OCTOBER 1935

metals and alloys

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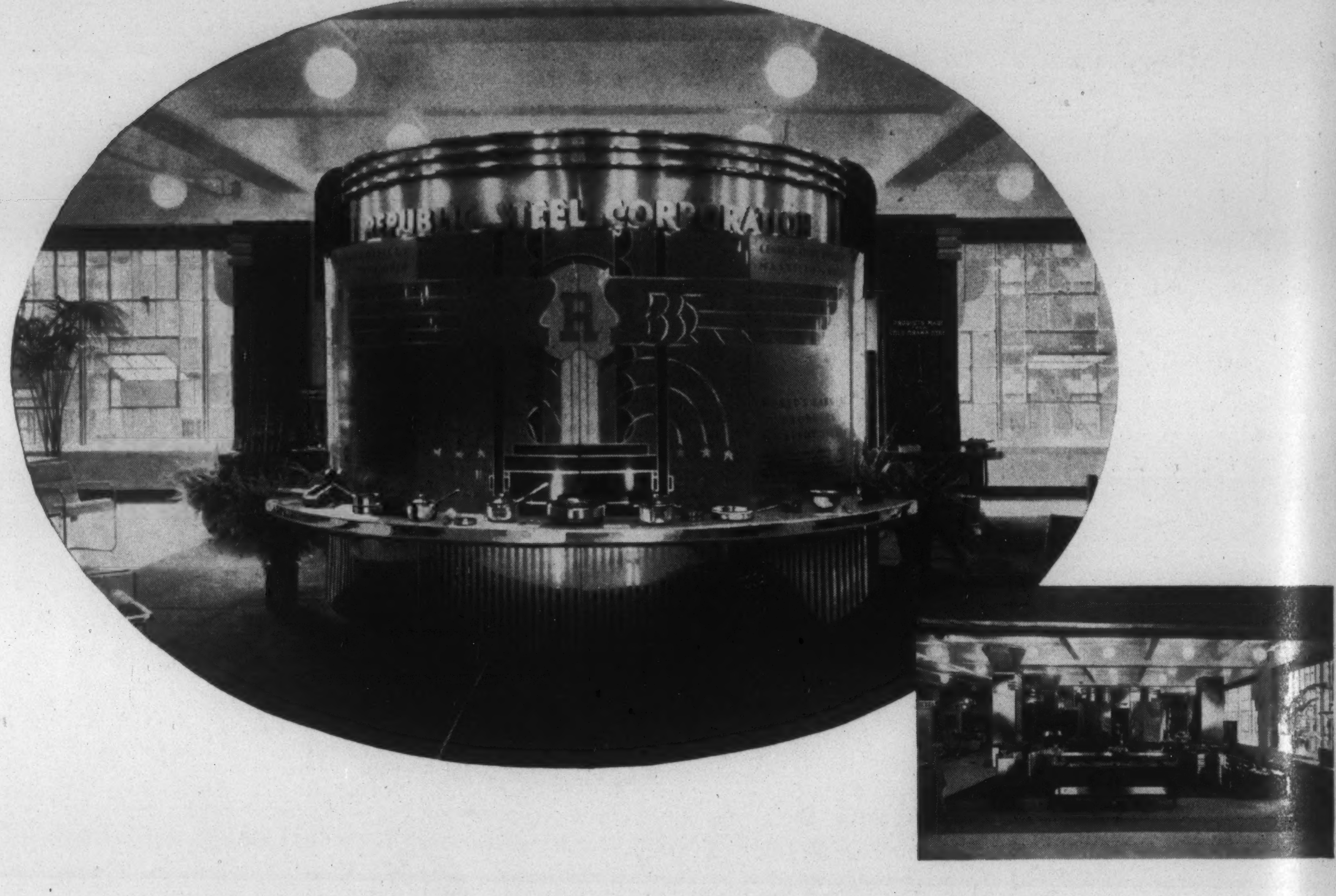
NATIONAL
METAL
XPOSITION
ISSUE

HEADQUARTERS *for* ALLOY STEELS



In Spaces B-3, C-3, D-3, B-5 and C-5 at the National Metal Exposition you'll find many interesting examples of the varied uses of Agathon Alloy Steels, of ENDURO Stainless and Heat-Resisting Steels and of other Republic products. But the Republic booth is more than merely an exhibit space. It is Alloy Headquarters, a place to meet your friends and discuss new developments with metallurgists of the world's largest producer of alloy steels—a metallurgical organization that is abreast of every development. » » » Feel free to drop in and ask questions. We have much to tell you about Agathon Alloy Steels . . . ENDURO, Republic's Perfected Stainless Steel . . . Republic's Double Strength Steel . . . and other Republic developments. Ask for a copy of the new Agathon Alloy Handbook.

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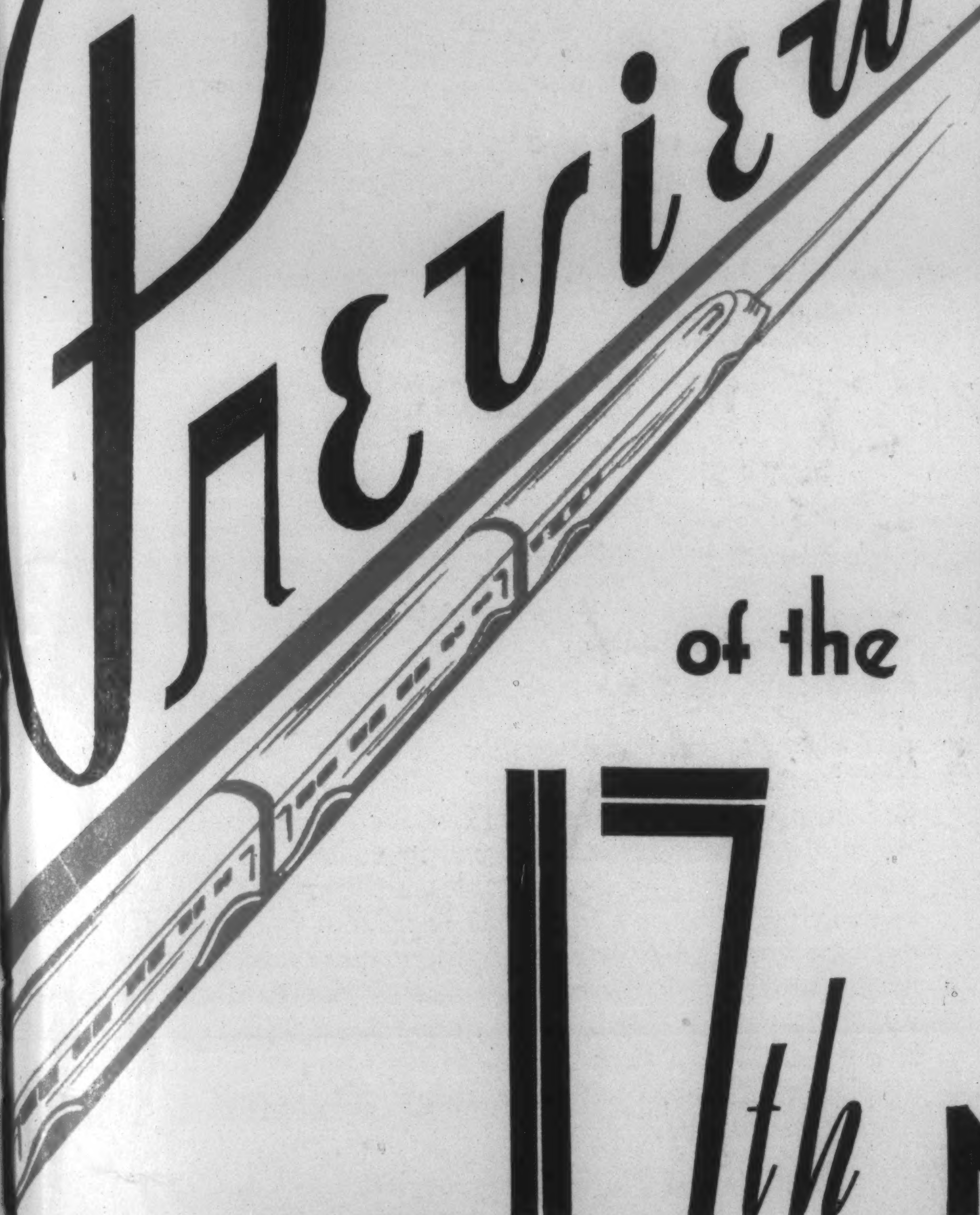
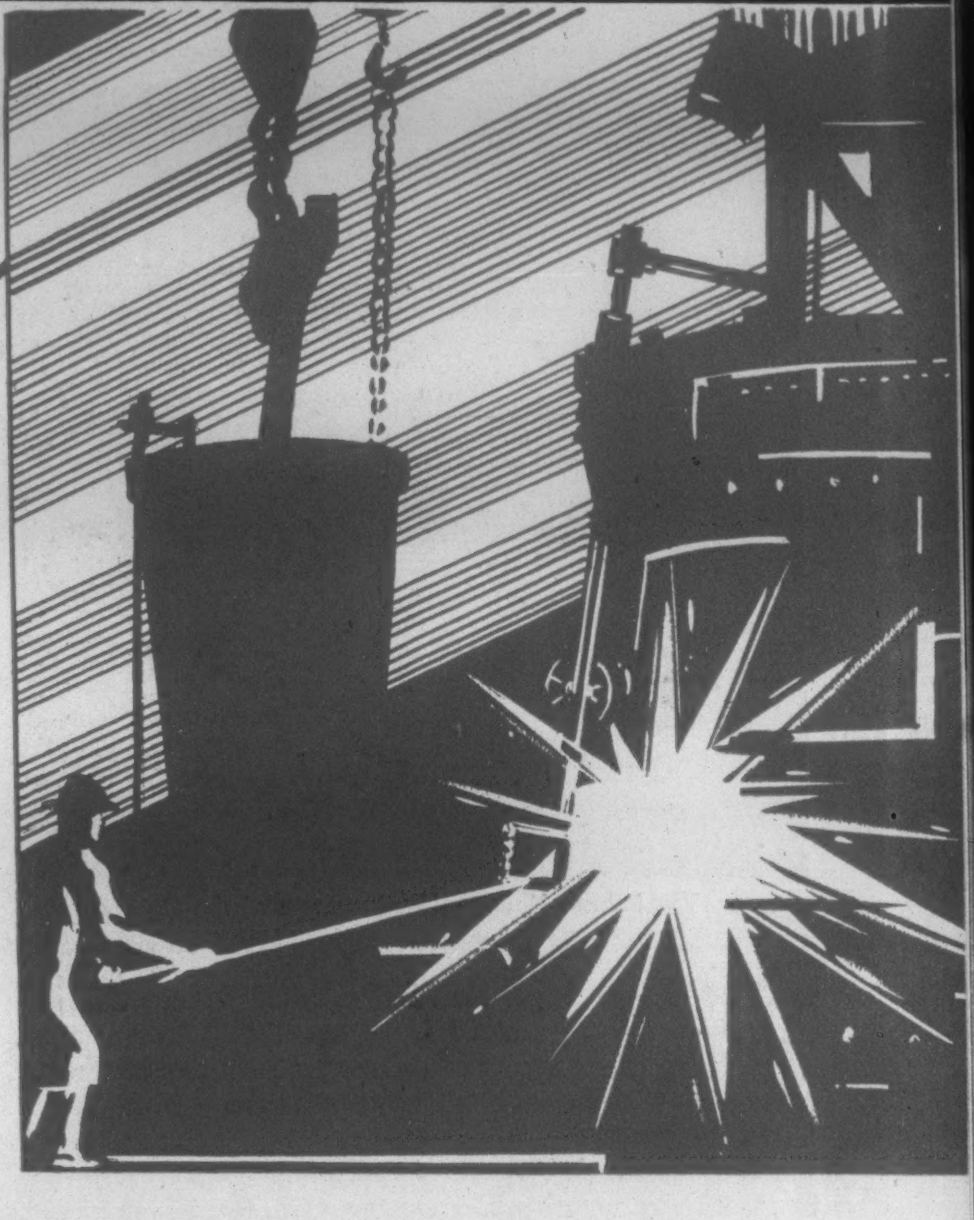
METALS and ALLOYS

Preview





of the

17th NATIONAL METAL EXPOSITION

SEPT. 30 - OCT. 4

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The Palmer House—Headquarters of the Congress

National Metal Week for 1935 in Chicago

ELABORATE PREPARATIONS for the annual gathering of iron, steel and metal men from this and other countries—an event looked forward to each year with keen anticipation—have been perfected. The National Metal Congress—the seventeenth—opens in Chicago this year on Sept. 30 and continues through Oct. 4. As in other recent years it is sponsored by the American Society for Metals, known until a year ago as the American Society for Steel Treating. The Congress will consist of a large Exposition and of technical programs by four other participating technical organizations.

The Exposition

The large auditorium of the New International Amphitheatre will house the exhibit, which will probably be the largest since the depression and perhaps the largest on record. As this goes to press 205 companies have reserved space "amounting to more than four acres," according to W. H. Eisenman, secretary of the A. S. M. and manager of the exposition. These companies represent every process, product and type of equipment employed by the metal working industry. A list of the exhibitors, what they will exhibit and those who will attend is presented on other pages, as well as a floor plan of the exposition which will be open every day from noon until 10 p.m.

The Participating Societies

In addition to the A. S. M. the National Metal Congress will include the American Welding Society, the Iron and Steel and the Institute of Metals

B. F. Shepherd

The president of the A.S.M., Mr. Shepherd is manager rock drill division, Ingersoll-Rand Co., Phillipsburg, N. J.

The secretary of the A.S.M. and manager of the Exposition is Mr. Eisenman.

W. H. Eisenman

Division of the American Institute of Mining and Metallurgical Engineers, and the Wire Association. Each one of these organizations has prepared a technical program appropriate to its respective field. The morning programs of the A. S. M. will be presented at the Palmer House, the headquarters of the Congress, with the afternoon sessions at the Amphitheatre. The other societies will hold their sessions at the Palmer House or the Congress Hotel as indicated by the programs published on other pages.

Special Lectures

Two novel features of the A. S. M. program this year include five lectures on "Heat Treatment of Steel" in the Exposition Hall by Dr. Marcus A. Grossman of the Illinois Steel Co., and three lectures on "Spectrographic Analysis" by E. J. Martin of the General Motors Corp. The Campbell Memorial Lecture will be delivered by H. W. McQuaid of the metallurgical department of the Republic Steel Corp.

The science lecture of the A. I. M. and M. E. will be delivered by Dr. Harold C. Urey, professor of chemistry, Columbia University. His subject will be "Recent Developments in Isotopic Chemistry." In 1934 Dr. Urey was awarded the Nobel Prize in chemistry for his discovery of "heavy hydrogen" and a scroll from the alumni association of the Graduate School of Columbia in recognition of his scientific endeavor as a "distinct contribution to the human race."

An extensive program of plant visitations has been arranged for different days during National Metal Week.

The October Issue of Metals and Alloys

READERS of METALS & ALLOYS will find in the October issue, which is the Pre-Convention Issue, nine articles on a variety of metallurgical engineering subjects. They represent both technical and practical discussions of live topics. The nine articles are briefly as follows:

Some facts as to the role that metals play in the radio tube industry are presented by Stanton Umbreit in an article "Some Metallurgical Aspects of the Radio Tube Industry." Mr. Umbreit is in the research laboratory of the RCA Mfg Co., Harrison, N. J. This article is another in a series on the metallurgical needs of the non-metallurgical industries.

Prof. William Campbell of Columbia University, known widely as a leading metallurgist, relates in a most interesting manner how he has found troostite, cementite, pearlite, Stead's brittleness and so on in armor dating back as far as 1460 in an article "On the Structure of Armor, Ancient and Modern." There are 19 photo-micrographs.

Ever since Ford introduced his cast metal crankshaft for the V-8 cars, there has been a large interest in its composition, properties and so on. Several articles have been published on the foundry operations involved but for the first time the story is told in an article, "The Story of the Ford Crankshaft" by the Editor, of how the elements were balanced in developing the composition of the "hybrid" metal in the crankshaft.

Chemistry is intimately tied up with metallurgy, as is evidenced by an article, "Rapid Determination of Nickel in 18 and 8," by Fred P. Peters, Wilbur B. Driver Co., Newark, N. J.

In the non-ferrous field is an article by F. M. Howell and D. A. Paul, of the Aluminum Research Laboratories of the Aluminum Co. of America, on "Properties of Wrought Aluminum Alloys at Elevated Temperatures"—a subject of primary commercial and metallurgical interest.

Is phosphorus an alloying element in steel or is it a "nuisance" is discussed in the first of two installments of a correlated abstract by Dr. H. W. Gillett, editorial director of METALS & ALLOYS. Some highly important facts are discussed which may lead one to believe that phosphorus is an alloy.

The second and last installment of "Progress in Spectrographic Analysis" by T. A. Wright—another correlated abstract—is also included. Evidence is ample that METALS & ALLOYS has gained a deserved prestige for its correlated abstracts on many subjects.

Another article is a discussion of "Manganese and Copper Additions to 18 and 8" by Leonard C. Grimshaw, Latrobe Electric Steel Co., based on his own investigations of "Armstrong Metal."

The third installment of Dr. Gillett's extensive investigation of "Controlled Atmospheres in Steel Treating" is the ninth article—a correlated abstract which brings up to date all the information on this important development and which has created wide interest.

Last, but by no means least, is the usual installment of Metallurgical Abstracts taken from articles in journals all over the world. By means of these, the modern metallurgists keep up with the times.

H. W. McQUAID

The Campbell Memorial Lecturer this year is Mr. McQuaid, metallurgist, Republic Steel Corp., Massillon, Ohio, collaborator of the McQuaid-Ehm test.

M. A. GROSSMAN

Dr. Grossman is research engineer, Illinois Steel Co., South Chicago, Ill.

Technical Program of the American Society for Metals

An outstanding feature of each annual National Metal Congress and Exposition is the technical program of the American Society for Metals.

The program for this year's Congress, which will open in Chicago on Monday, Sept. 30, will include papers dealing with present-day problems and developments in every branch of the metal industry. There will be 39 papers presented. For the first time in the history of the Metal Congress, there will be evening lectures. These will be delivered by Dr. M. A. Grossman, on the "Heat Treatment of Steel." Many authorities in the metal world have contributed their time and their wide experience to the preparation of the following program:

Monday, Sept. 30

Morning: Palmer House Ball Room

"On the Preparation of Iron and Steel Specimens for Microscopic Investigations," by F. F. Lucas, Bell Telephone Laboratories, New York.

"Oxalic Acid as an Electrolytic Etching Reagent for Stainless Steels" by G. A. Ellinger, U. S. Bureau of Standards, Washington.

"On Naming the Aggregate Constituents in Steel," by J. R. Vilella, G. E. Guellich and E. C. Bain, United States Steel Corp., New York.

Afternoon: Exposition Hall

"Arc Welding of High-Carbon and Alloy Steels," by T. N. Armstrong, Norfolk Navy Yard, Portsmouth, Va.

"A Dilatometric Study of the Alpha-Gamma Transformation in High Purity Iron," by C. Wells, R. A. Ackley and R. F. Mehl, Carnegie Institute of Technology, Pittsburgh.

"Some Transient Phase Changes During the Graphitizing Reaction," by H. A. Schwartz, H. H. Johnson, and C. H. Junge, National Malleable & Steel Casting Co., Cleveland.

Grossman Lecture—"Heat Treatment of Steel" (Exposition Hall).

Evening: Exposition Hall

"Spectrographic Analysis," by E. J. Martin.

Tuesday, Oct. 1

Morning: Palmer House Ball Room

"High Temperature Properties of Ni-Co-Fe Base Age-Hardening Alloys," by C. R. Austin, Pennsylvania State College, State College, Pa.

"Grain Size and Its Influence on Surface Decarburization of Steel," by D. H. Rowland and Clair Upthegrove, University of Michigan, Ann Arbor, Mich.

"Observations on the Oxidation of Steel," by M. Baeyertz, Illinois Steel Co., South Works, Chicago.

Morning: Simultaneous Session, Palmer House

"Chromium Steels of High Nitrogen Content," by Russell Franks, Union Carbide & Carbon Research Laboratories, Niagara Falls, N. Y.

"Correlation of Failures from Embrittlement of 4 to 6 per cent Chromium Steel with the Notched Bar Impact Test," by H. M. Wilten, The Texas Co., Port Arthur, Texas.

"Factors Influencing the Nature of the Cutting Speed-Tool Life Curve," by O. W. Boston, W. W. Gilbert and C. E. Kraus, University of Michigan.

Afternoon: Exposition Hall

"Physical Properties of Metals as Affected by Ammonia Synthesis," by H. L. Maxwell, E. I. du Pont de Nemours & Co., Wilmington, Del.

"Influence of Carbon Content on the High Temperature Properties of Steels," by A. E. White, C. L. Clark, University of Michigan; and R. L. Wilson, Timken Steel & Tube Co., Canton, Ohio.

"A New Heat Resistant Alloy," by S. L. Hoyt and M. A. Scheil, A. O. Smith Corp., Milwaukee, Wis.

Grossman Lecture—"Heat Treatment of Steel" (Exposition Hall)

Evening: Exposition Hall

"Spectrographic Analysis," by E. J. Martin.

Wednesday, Oct. 2

Morning: Palmer House Ball Room

Annual Meeting of A.S.M.

Campbell Lecture, by H. W. McQuaid.

Afternoon: Exposition Hall

"Effect of Carbon, Oxygen and Grain Size on the Magnetic Properties of Iron-Silicon Alloys," by T. D. Yensen, Westinghouse Electric & Mfg. Co., E. Pittsburgh, and N. A. Ziegler, West Penn Electric Co., Pittsburgh.

"Relation of Hot Working to the McQuaid-Ehn Grain Size" by H. A Grove, Republic Steel Corp., Canton, Ohio.

"Austenitic Grain Size in Cast Iron," by D. W. Murphy and W. P. Wood, University of Michigan, Ann Arbor, Mich.

Grossmann Lecture—"Heat Treatment of Steel" (Exposition Hall).

Evening: Exposition Hall

"Spectrographic Analysis," by E. J. Martin.

Thursday, Oct. 3

Morning: Palmer House Ball Room

"Notes on the Solidus Temperatures in the Systems Iron-Tungsten and Iron-Molybdenum, by W. P. Sykes, General Electric Co., Cleveland.

"The Influence of Deoxidation on the Aging of Mild Steels," by B. N. Daniloff, R. F. Mehl, Carnegie Institute of Technology, Pittsburgh; and C. H. Herty, Jr., Bethlehem Steel Co., Bethlehem, Pa.

"The Aging of Steel," by E. S. Davenport and E. C. Bain, United States Steel Corp., New York.

Afternoon: Exposition Hall

"Endurance of Case Hardened Gears," by O. W. McMullan, International Nickel Co., Bayonne, N. J.

"Pickle Pitting by Electrolytic Potentials as Affected by Scaling Temperatures," by C. H. McCollam, and D. L. Warrick, Timken Steel & Tube Co., Canton, Ohio.

"Damping Capacity, A Factor in Fatigue," by G. R. Brophy, General Electric Co., Schenectady, N. Y.

Grossman Lecture—"Heat Treatment of Steel" (Exposition Hall)

Friday, Oct. 4

Morning: Palmer House Ball Room

"Hardening Characteristics of One Per Cent Carbon Tool Steels," by T. G. Digges and Louis Jordan, U. S. Bureau of Standards, Washington.

"Interpretation of Torsion Impact Properties of Carbon Tool Steel," by G. V. Luerssen and O. V. Greene, Carpenter Steel Co., Reading, Pa.

"Contributory Effects of Furnace Atmospheres on the Grain Size of Molybdenum High-Speed Steel," by Arthur Phillips and M. J. Weldon, Yale University, New Haven, Conn.

Afternoon: Exposition Hall

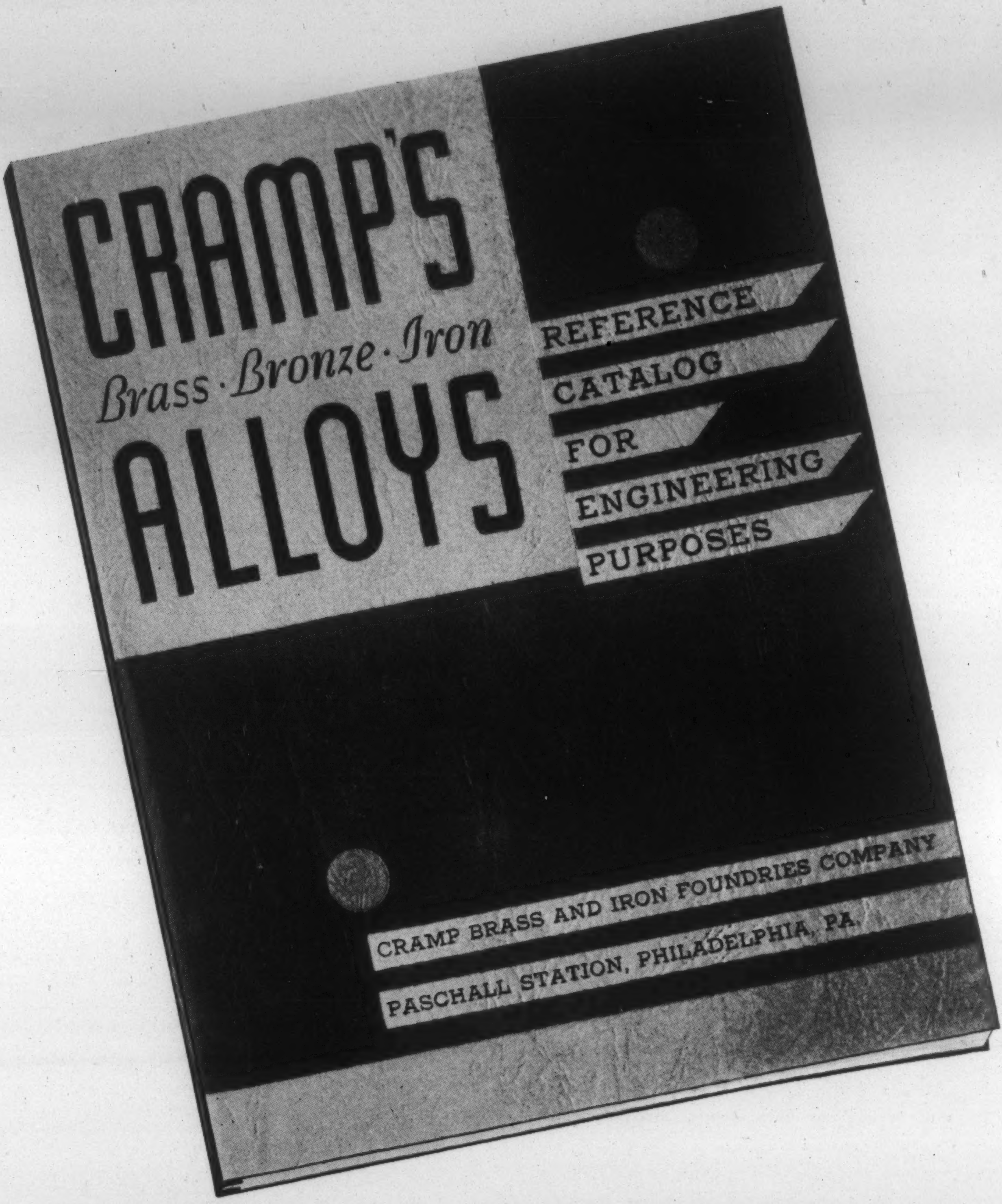
"Open-Hearth Temperature Control," by Earnshaw Cook, American Brake Shoe & Foundry Co., Chicago Heights, Ill .

"The Effect of Deoxidation on the Rate of Formation of Ferrite in Commercial Steels," by D. L. McBride, Carnegie Institute of Technology, Pittsburgh; C. H. Herty, Jr., Bethlehem Steel Co., Bethlehem, Pa.; and R. F. Mehl, Carnegie Institute of Technology, Pittsburgh.

"Equilibrium in the Reaction of Hydrogen with Ferrous Oxide in Liquid Iron at 1600 Deg. C.," by John Chipman, American Rolling Mill Co., Middletown, Ohio, and M. Fontana, E. I. du Pont de Nemours, Wilmington, Del.

Grossmann Lecture—"Heat Treatment of Steel" (Exposition Hall).

« ANNOUNCING »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Technical Program of the American Welding Society

FOR the fifteenth fall meeting of the American Welding Society, during this National Metal Congress, an elaborate technical program has been prepared. Over 20 technical papers are scheduled. Features of the program include two sessions on "Fundamental Research" and a symposium on "Methods of Minimizing Distortion," and one on "Low Alloy Steels for Welding Purposes." All sessions will be held in the Palmer House.

Details of the technical program follow:

Monday, Sept. 30

Afternoon: Opening Session

Introduction of President of American Welding Society by D. C. Wright, Chairman, Chicago Section.

Address of welcome by local celebrity.

Response.

Presentation of Miller Memorial Medal Award.

Technical Session

"Bridge Welding—A Review of the Literature," by F. H. Frankland, vice-chairman, Committee to Study Welding of Highway and Railroad Bridges.

"Nitrogen in Metallic Arc Weld Metal," by Dr. J. W. Miller, Reid Avery Co.

Evening:

Dinner Meeting, Board of Directors, Palmer House.

Tuesday, Oct. 1

Morning: Technical Session—Fundamental Research

"Spot Welding Problems," by J. H. Zimmerman, Massachusetts Institute of Technology.

"Bend Testing of Welds—A Summary," by M. F. Sayre, Union College.

"Advantages of Welding in Continuous Structures," by Inge Lyse, Fritz Engineering Laboratory, Lehigh University.

Afternoon: Technical Session—Fundamental Research

"Arc Welding with Pure Iron Welds," by Gilbert E. Doan, Lehigh University.

"Investigations of Residual Stresses," by R. E. Jamieson, McGill University.

"Low Temperature Tests of Welds," by Otto Henry, Brooklyn Polytechnic Institute.

"Creep Tests of Welds," by N. F. Ward, University of California.

Evening: Conference and Meeting of Fundamental Research Committee, American Bureau of Welding

This conference is scheduled for the benefit of university research workers in the fundamentals of welding.

Wednesday, Oct. 2

Morning: Technical Session

"Tests to Determine the Feasibility of Welding the Steel Frames of Buildings for Complete Continuity," by W. M. Wilson, University of Illinois.

"Welding All-Metal Radio Tubes," by M. L. Eckman, Thomson-Gibb Electric Welding Co.

"A New General-Purpose Meter for Resistance Welding," by C. Stansbury, Cutler-Hammer, Inc.

Afternoon: Technical Session—Symposium on Methods of Minimizing Distortion

1. Pressure Vessels: J. T. Phillips, Foster Wheeler Co.
2. Repair Welding: Geo. Hettrick, President, Anchor Welding Service Inc.
3. Light Gage Steel: J. H. Blaha, General Household Utilities Co.

"Machine Torch Cutting and Fabrication of Tool Equipment," by P. H. Danly, Danly Machine Specialties Company.

Thursday, Oct. 3

Morning: Technical Session—Symposium on Low Alloy Steels for Welding Purposes

"The Development and Use of Low Alloy High Tensile Steels in Welded Construction," by A. E. Gibson, The Wellman Engineering Co.

"Welding of Alloy Steels," by H. L. Miller, Republic Steel Co., J. C. Holmberg, Struthers-Wells-Titusville Corp., and Corbin Chapman, Hedges-Walsh-Weidner Co.

Afternoon: Technical Session

"Welding of Alloy Steels," by J. C. Hodge, Babcock & Wilcox Co.

"Effect of Generator Characteristics on the Weld," by J. H. Blankenbuehler, Westinghouse Electric & Mfg. Co.

"Electrical Characteristics of the Welding Arc," by S. C. Osborne, Wilson Welder & Metals Co. Inc.

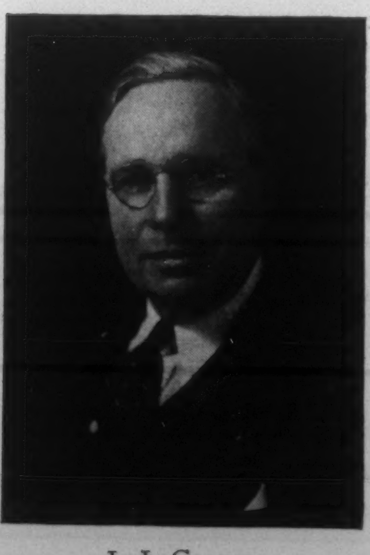
"Resistance Welding of Copper Alloys," by I. T. Hook, American Brass Co.

Evening: Annual Banquet—Palmer House

Friday, Oct. 4

Morning and Afternoon: Inspection Trips

Chicago Section is making novel arrangements for the benefit of executives in the metal working industry to visit a group of plants in and around the Chicago district in order to see first hand the varied applications of welding. Probably two routes will be arranged and provision made to accommodate both groups at lunch time. Details as to the plants to be visited will be announced shortly.

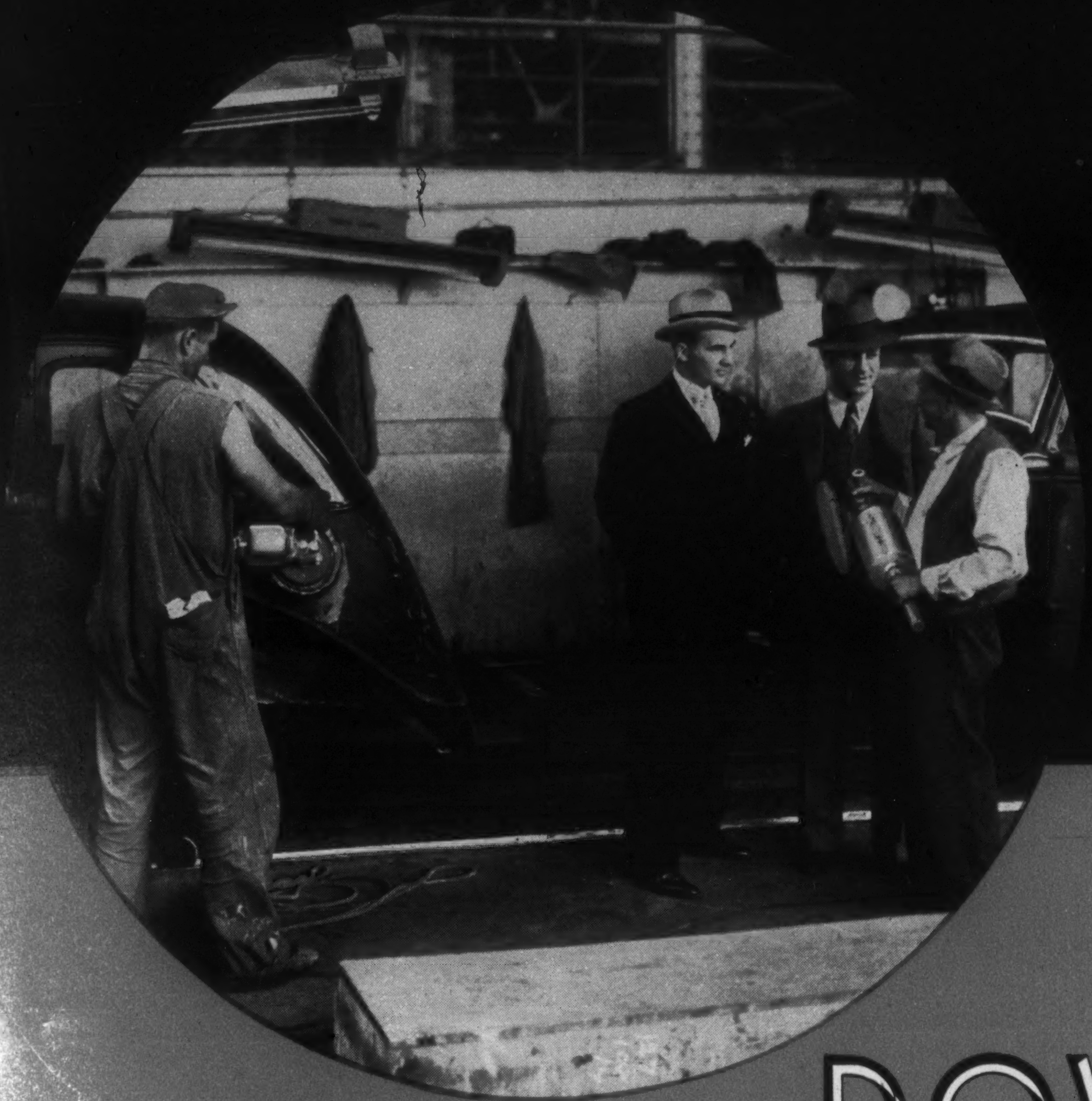


J. J. CROWE

Mr. Crowe is president of the A. W. S. He is in charge of apparatus research and development, Air Reduction Co., New York.

Mr. Spraragen is secretary of the A. W. S. and editor of the society's *Journal*.

WILLIAM SPRARAGEN



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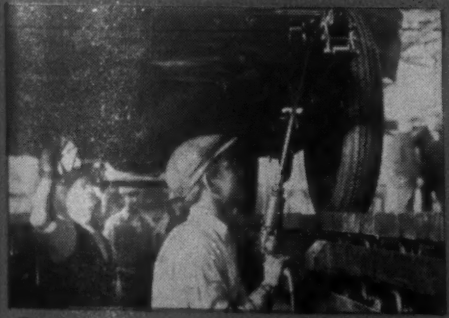

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MAGNESIUM ALLOYS

Iron and Steel and Institute of Metals Divisions of the A.I.M. and M.E. Technical Programs

EXTENSIVE preparations have been made for an interesting week for members of the iron and steel and of the institute of metals divisions of the mining engineers. All sessions will be held at the Palmer House except on Wednesday afternoon, Oct. 2, when the two divisions will meet separately at the International Amphitheatre. The meetings run from Oct. 1 to 3, and the program follows:

Tuesday, Oct. 1

9 a.m.—Registration.
10 a.m.—*Iron and Steel Division.*

Blast Furnaces and Raw Materials

"Production and Preparation of Blast-furnace Flux," by Paul C. Hodges.
"Blast-furnace Air-blast Beneficiation," by Theodore Nagel.

10 a.m.—*Institute of Metals Division.*

Constitution

"An Investigation of the Zinc-rich Portion of the System Iron-Zinc," by E. C. Truesdale, R. L. Wilcox and J. L. Rodda.
"Influence of Lattice Distortion on Diffusion in Metals," by V. G. Mooradian and John T. Norton.
"A Study of the Molybdenum-carbon System," by W. P. Sykes, Kent R. Van Horn and C. M. Tucker.

2 p.m.—*Iron and Steel Division.*

Round Table on Qualities of Pig Iron

"Five Years of Progress in Southern Merchant Iron Production," by Francis H. Crockard.
"Beneficiation of Michigan Iron Formations," by Frank J. Tolanen.

2 p.m.—*Institute of Metals Division.*

Reactions in Alloys

"Studies of Phase Changes during Aging of Zinc-alloy Die Castings, II—Changes in the Solid Solution of Aluminum in Zinc and Their Relation to Dimensional Changes," by M. L. Fuller and R. L. Wilcox.
"Quenching Stresses and the Precipitation Reaction in Aluminum-Magnesium Alloys," by R. M. Brick, Arthur Phillips and A. J. Smith.
"Notes on the Crystallization of Copper," by Alden B. Greninger.

Wednesday, Oct. 2

12:30 p.m.—Luncheon Meeting, Executive Committee, Iron and Steel Division. Palmer House.
12:30 p.m.—Luncheon Meeting, Executive Committee, Institute of Metals Division. Palmer House.
2 p.m.—*Iron and Steel Division.*

General Session

"The Initial Stages of the Magnetic and Austenitic Transformations in a Carbon Steel," by I. N. Zavarine.
"Notes on the Origin and Growth of Graphite Nuclei in Solid and Liquid Iron Solutions," by H. A. Schwartz and Wolfram Ruff.
"Separation of Hematite by Means of Hysteretic Repulsion," by E. W. Schilling and Harwick Johnson.

2 p.m.—*Institute of Metals Division.*

Gas-metal Systems

"Reduction of Chromic Oxide by Hydrogen," by F. C. Kelley.
"Solubility of Oxygen in Solid Cobalt and the Upper Transformation Point of the Metal," by A. U. Seybolt and C. H. Mathewson.
"Thermal and Electrical Conductivities of Copper Alloys," by Cyril Stanley Smith and Earl W. Palmer.
"An Apparatus for Determining Creep in Single Crystals," by R. F. Miller.

6:30 p.m.—Dinner, Iron and Steel and Institute of Metals Divisions. Palmer House. Speaker, Carl W. Volz, Norwegian Smelting Works, Electric Furnace Products Co.; subject, "Metallurgy in Norway."

Thursday, Oct. 3

9:30 a.m.—*Iron and Steel Division.*

Temperature Measurements of Liquid Iron and Steel

"Some Metallurgical Applications of the Fitterer Pyrometer," by G. R. Fitterer.
"Temperature Measurements with the Disappearing-filament Optical Pyrometer," by W. E. Forsythe.

[This session is a round table to which are especially invited the approximately 70 members of the Conference on the Physical Chemistry of Steelmaking. In order to stimulate free discussion the names of those who participate will be withheld from the record of the meeting unless otherwise specifically requested. There will be several formal papers to serve as a nucleus for the discussion.]

4 p.m.—*Science Lecture,* Iron and Steel and Institute of Metals Divisions. By Harold Clayton Urey, professor of chemistry, Columbia University; subject, "Recent Developments in Isotopic Chemistry." Palmer House.

A. B. Kinzel

Dr. Kinzel is chairman of the Iron and Steel Division. He is chief metallurgist, Union Carbide & Carbon Research Laboratories, New York.

Mr. Peirce is chairman of the Institute of Metals Division. He is assistant to chief of research, research division, New Jersey Zinc Co., Palmerton, Pa.

W. M. Peirce

Technical Program of the Wire Association

THE annual meeting of the Wire Association will be held at the Congress Hotel, Sept. 30 to Oct. 4, as usual, in conjunction with the National Metal Congress. Registration, the annual meeting and the directors' meeting are scheduled for Sept. 30. An informal dinner will be held on Wednesday, Oct. 2.

Among the papers and addresses to be presented at the technical sessions will be the following, according to an announcement from the program committee:

"Acid Cleaning and Material Handling of Rods and Wire," by Frederick A. Westphal, superintendent, wire mill, Sheffield Steel Co., Kansas City, Mo.

"Grain Size and Its Influence on the Manufacture of Steel Wire," by B. L. McCarthy, metallurgist, Wickwire-Spencer Steel Co., Buffalo.

"Industrial Relations as Applied to the Wire Industry," by E. W. Kempton, director of industrial relations, American Steel & Wire Co., Cleveland.

"Cold Heading Wire," by L. D. Seymour, metallurgist, Youngstown Sheet & Tube Co., Youngstown.

"Tests and Testing," by C. A. Kellogg, metallurgist, Continental Steel Corp., Kokomo, Ind.

"Modern Acid Handling Methods Lower Pickling Costs," by J. R. Hoover, assistant manager, Chemical Sales Division, The B. F. Goodrich Co., Akron, Ohio.

"The Effect of Grain Size on the Physical Properties of Copper in Drawing and Annealing," by Dr. L. B. Barker, S. M., metallographer, General Electric Research Laboratories, and A. E. Bailey, in charge of testing laboratory, Wire Dept., General Electric Co., Schenectady, N. Y.

"Hard and Soft Copper Wire," by Rudolph A. Schatzel, superintendent, General Research Laboratories, General Cable Corp., Rome, N. Y.

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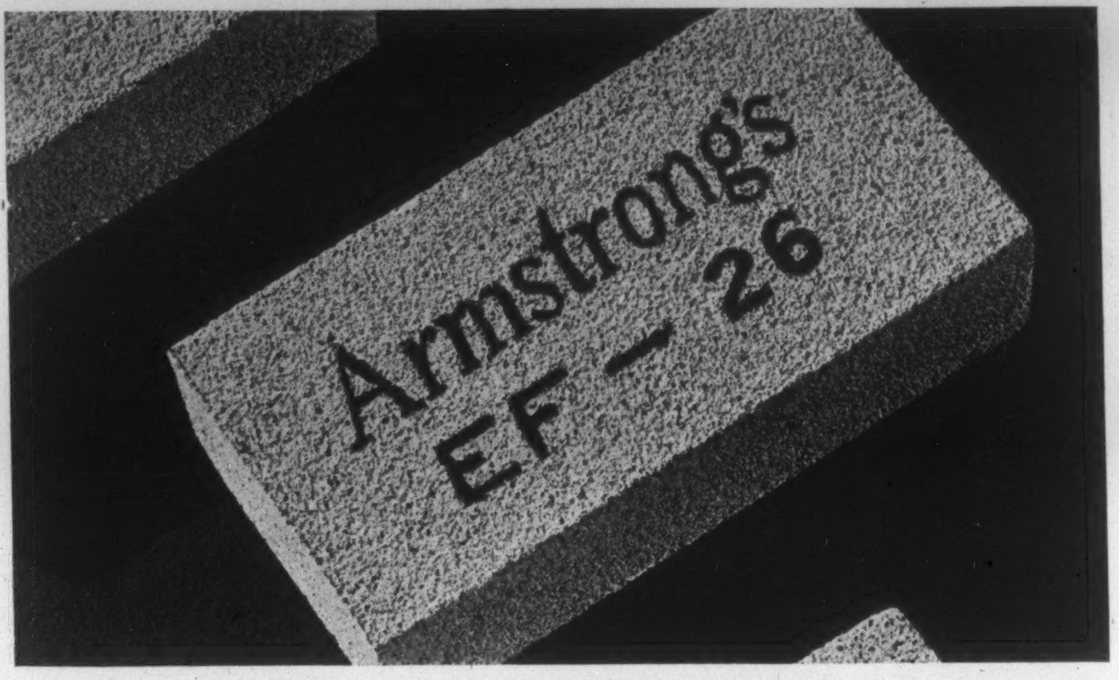

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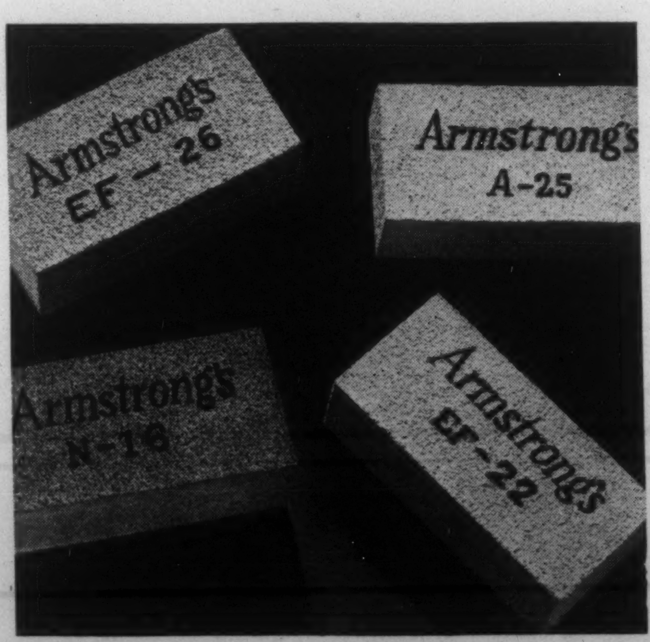
HERE'S the latest development in light-weight, semi-refractory brick! The new Armstrong's EF-26 will not crack, fuse, or spall at temperatures as high as 2600° F. And it offers all the operating advantages which have made Armstrong's EF Brick the choice of leading furnace builders and plant supervisors.

For Armstrong's EF-26 requires no fire brick protection, except when exposed to the direct impingement of the flame or slagging action. This permits the use of thinner walls, with a consequent sharper furnace, shorter heating time, speedier production line, and a real saving on fuel cost.

Armstrong's EF-26 is suitable for all types of furnaces—gas, oil, coal, or electric-operated. It is especially well suited for bright annealing furnaces since it contains no free iron to combine with the gases usually introduced into this type of furnace. The standard brick (9" x 4½" x 2½") weighs three pounds, and has a crushing strength (cold) of 450 lbs. per square inch, 545 lbs. at 1800° F., 265 lbs. at 2100° F., and 125 lbs. at 2500° F.

For samples and further information about Armstrong's EF-26—or about any of Armstrong's other brick—write to Armstrong Cork Products Co., Building Materials Division, 982 Concord Street, Lancaster, Penna.



IMPORTANT!

New, simplified markings of other brick in Armstrong's complete line

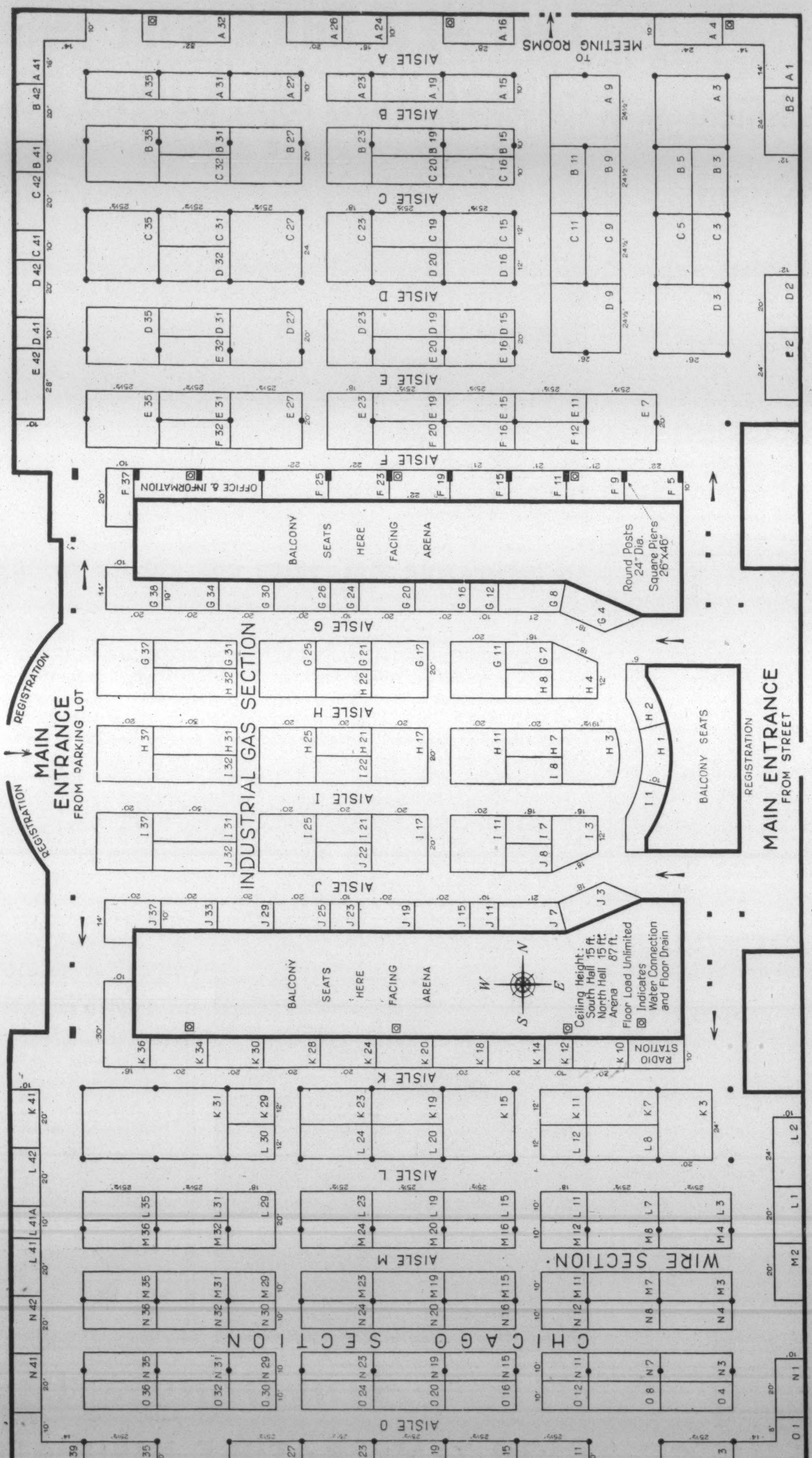
ARMSTRONG'S N-16 (formerly designated *Nonpareil 1600*) a light-weight insulating brick for temperatures up to 1600° F. behind the refractory.

ARMSTRONG'S A-25 (formerly designated *Armstrong 2500*) the standard insulating brick for temperatures up to 2500° F. behind the refractory.

ARMSTRONG'S EF-22 (formerly designated *EF*) an insulating fire brick for direct exposure up to 2200° F.

Armstrong's

HIGH TEMPERATURE INSULATION


TO MEETING ROOMS
MAIN ENTRANCE FROM PARKING LOT
REGISTRATION
REGISTRATION
MAIN ENTRANCE FROM STREET
REGISTRATION
INDUSTRIAL GAS SECTION
WIRE SECTION
CHICAGO SECTION
OFFICE & INFORMATION
BALCONY SEATS HERE FACING ARENA
BALCONY SEATS HERE FACING ARENA
BALCONY SEATS
RADIO STATION
Round Posts 24" Dia.
Square Piers 26"x46"
Ceiling Height: South Hall 15 ft. North Hall 15 ft. Arena 87 ft.
Floor Load Unlimited
☐ Indicates Water Connection and Floor Drain
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AISLE B
AISLE C
AISLE D
AISLE E
AISLE F
AISLE G
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A. Milne & Co., New York.—Booth L-41.
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Molybdenum Corp. of America, Pittsburgh.—Booth F-25.
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Selas Co., Philadelphia.—Booth G-34.
Sellstrom Mfg. Co., Chicago.—Booth N-4-B.
Seymour Mfg. Co., Seymour, Conn.—Booth M-19.
The Shore Instrument & Mfg. Co., Jamaica, N. Y.—Booth M-31.
Sivyer Steel Casting Co., Milwaukee, Wis.—Booth J-10.
South Bend Lathe Works, South Bend, Ind.—Booth O-15.
Spencer Turbine Co., Hartford, Conn.—Booth H-11.
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Steel, Cleveland.—Booth E-34.
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Steel Publications, Inc., Pittsburgh.—Booth K-12.
Steel & Tubes, Inc., Cleveland.—Booth D-3.
Charles G. Stevens Co., Chicago.—Booth M-8.
N. A. Strand & Co., Chicago.—Booth K-24.
D. A. Stuart & Co., Chicago.—Booth A-4.
Surface Combustion Corp., Toledo.—Booth H-25.
Sutton Engineering Co., Pittsburgh.—Booth L-29.
C. J. Tagliabue Mfg. Co., Brooklyn.—Booth I-11.
Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., (U. S. Steel Corp. Subsidiary).—Booth E-16.
Thermo Control Devices, Inc., Chicago.—Booth L-1.
The Thomas Steel Co., Warren, Ohio.—Booth E-19.
The Timken Steel & Tube Co., Canton, Ohio.—Booth A-9.
The Titanium Alloy Mfg. Co., Niagara Falls, N. Y.—Booth D-35.
The Udylite Co., Detroit.—Booth A-1.
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Wilkens-Anderson Co., Chicago.—Booth M-2.
The Youngstown Sheet & Tube Co., Youngstown, Ohio.—Booth 824 and 826.
Ziv Steel & Wire Co., Chicago.—Booth K-14.

Exhibitors and What They Will Present

Seventeenth National Metal Exposition, Chicago, 1935

Air Reduction Sales Co., New York—Booth E-23.
Exhibit (in operation): A style "No. 6 Oxygraph" suitable in fabricating machine parts, bases, etc.; a style "No. 7 Oxygraph" designed for shape cutting to precise forms and dimensions; a "No. 1 Omnigraph," a semi-automatic machine in which the torch is driven by a magnetic roller contacting with the periphery of a cam or templet of the form required to produce the desired shape. The addition of one attachment converts it into a shape cutting machine that may be operated without the use of the magnetic tracing device. The "Airco-DB No. 1 Tractograph," a portable, motor-propelled, hand-guided oxyacetylene cutting machine for cutting steel plate and slabs in simple or intricate shapes over extended areas, will be demonstrated extensively.

The "No. 4 Radiagraph" with new attachments will be demonstrated. The pipe cutting and beveling machine for cutting off and beveling pipe ranging from 4 to 36 in. in diameter in one operation will be demonstrated. The "Airco Tensile and Bend Testing Machine" will be demonstrated, to test the strength of welds. The "Aircobraze" outfit will be demonstrated on "Wal-Seal Fittings," and the use of "Sil-Fos" with this outfit also will be shown. Hard facing operations will be conducted with Stoody products. Also on demonstration will be the "Airco-DB" hand welding and cutting apparatus including multistage regulators. National carbide lights and lanterns will be demonstrated. Airco oxygen and acetylene cylinders as well as the complete line of Airco welding and cutting supplies will be on display.

A Wilson model "S-A" Electric Arc Welding Machine," manufactured by the Wilson Welder & Metals Co., will be demonstrated.

In attendance: C. D'W. Gibson, assistant vice-president and general sales manager; W. H. Ludington, manager applied engineering department; J. F. Pyror, assistant to general sales manager; E. F. Pettigrew, manager of gas sales; H. W. Reade, apparatus sales manager; G. Van Alstyne, advertising manager; H. L. Rogers, assistant manager applied engineering department; F. E. Rogers, applied engineering department; R. F. Helmkamp, engineer; M. M. Weist, district manager, Chicago; J. P. Burns, sales representative; J. L. Campbell, sales representative; R. F. McNutt, sales representative; J. N. Harkins, sales representative; J. F. Callahan, advertising assistant; J. B. Adams, Jr., sales representative; W. Whaley, sales representative; J. F. Franzen, supervisor; W. T. Love, serviceman; A. J. Vrooman, serviceman; R. C. Holcomb, National Carbide Sales Corp.; T. B. Hasler, president Wilson Welder & Metals Co.; F. S. Stewart, P. M. Mattern, H. Schemm, W. Brainard, and E. Walters.

Ajax Electrothermic Corp., Trenton, N. J.—Booth A-6.
Exhibiting: Small furnaces, furnace model and photographs of installations.
In attendance: G. H. Clamer, president and general manager; Dudley Willcox, treasurer and assistant general manager; R. N. Blakeslee, secretary and sales manager; and A. D. Meyer, sales metallurgist.

Allegheny Steel Co., Brackenridge, Pa.—Booth C-27.
Exhibiting: Exhibits will feature the many applications of "Allegheny Metal" and other grades of Allegheny time tested stainless steels. Fabricated articles of interest to all as well as various samples of commercial forms such as sheets, bars, plates, tubing, wire, etc., will be on display in our booth.
In attendance: W. J. McArdle, general sales manager; R. N. Allen, assistant general sales manager; W. R. Grunow, engineer; K. F. Tennison, engineer; C. W. Messinger, western sales representative; Don Smith, manager of Chicago district; J. J. Petch, sales engineer; Clark W. Green, advertising, in charge of exhibit; and V. N. Krivobok, associate director of research.

Edgar Allen Steel Co., Inc., Chicago.—Booth L-41.
Exhibiting: Imperial "Major" high-speed steel; "Extra special" high-speed steel; "special" high-speed steel; turning and finishing steel; "Minerva" air hardening steel; self hardening steel; special chisel steel; red label steel; tack knife steel; die casting steel; solid double six production steel; hollow double six production steel; class "P" tool steel; class "E" tool steel; stag tool steel and talon tool steel.
In attendance: H. S. Hoyt, member of firm; J. King Hoyt, Jr., member of firm; V. A. Greene, sales manager; H. R. Adams, Chicago branch manager; E. R. Carnell, salesman; C. C. Pinkney, salesman; R. P. Rice, salesman; J. I. Kitts, salesman; and E. Q. Sylvester, salesman.

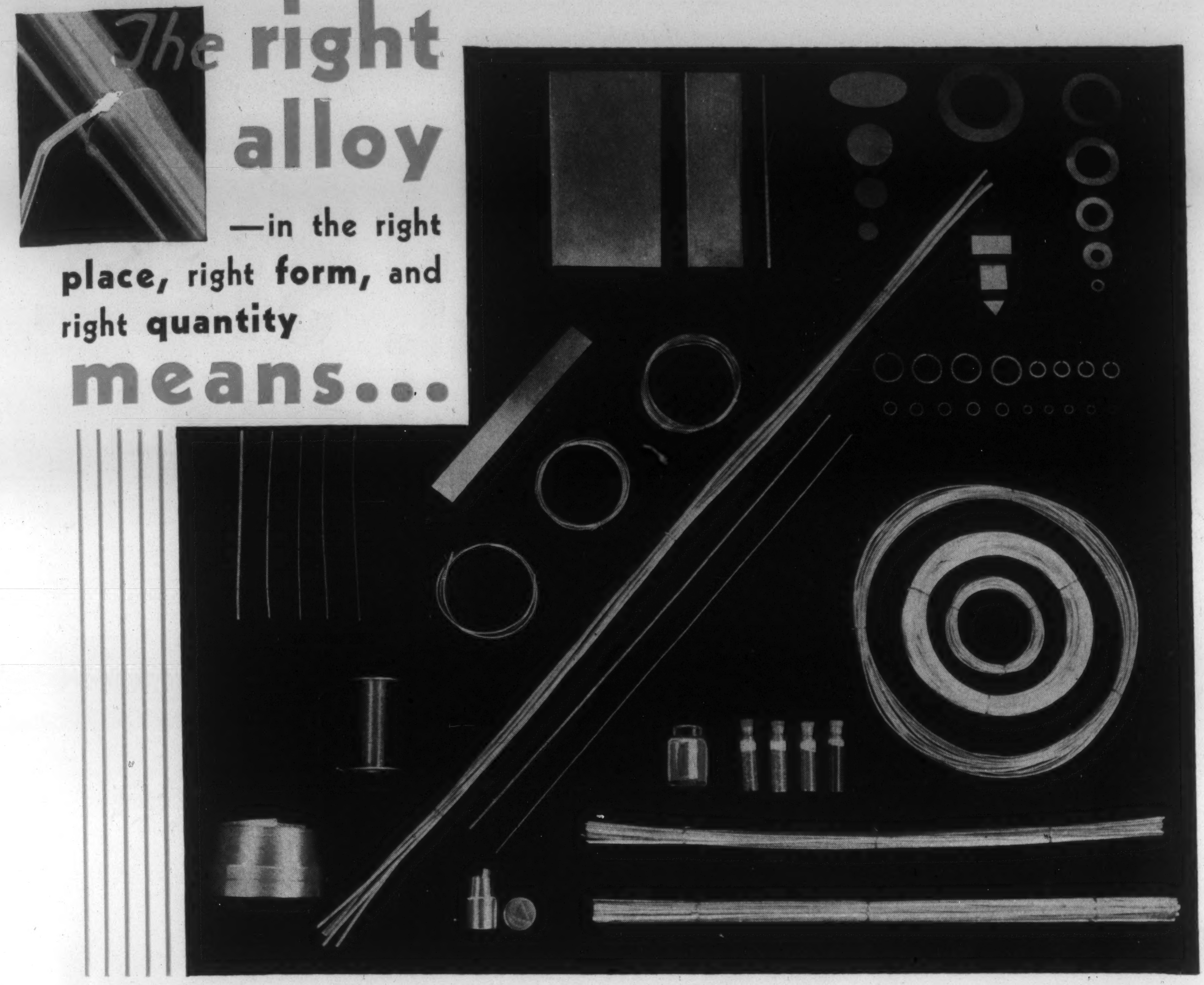
The American Brass Co., Waterbury, Conn.—Booth B-2.
Exhibition in operation: The central feature of the display will be a welding booth, where C. E. Swift, welding engineer, will give demonstrations of gas, and "high voltage" arc welding. The arc welding will be with samples of copper, brass and bronze, using Anaconda Phosphor Bronze "D" welding rods. The oxy-acetylene welding will be with Tobin bronze rods. In addition to the operating section of the exhibit, there will be displays of welded Everdur tanks; cast iron parts, repair welded with Tobin bronze; and a complete display of Anaconda welding rods.
In attendance: C. E. Swift, W. E. Swift, W. C. Wallis, N. Brandtberg and W. H. Dowd.

American Car & Foundry Co., New York.—Booth A-31.
Exhibiting (in operation): No. 3 two-electrode fully-automatic heater for heating any diameter stock from ¼ to 1 in. giving any length heat desired from 1 to 20 in. on any length stock from 4 to 24 in. Material is placed in a hopper, automatically fed between the electrodes and when the temperature is reached at which the electric eye is set the jaws automatically release the hot piece and the cold piece drops into place. No. 2 two-electrode Berwick electric rivet heater for heating rivets of any diameter from 3/16 to ¾ in. and of any length from 1 to 6 in. Valve stem or end rod heater for heating from 1 to 2 dia. of any diameter stock inserted from ¼ up to ¾ in. Equipped with timing device in addition to electric eye so that when the end of the piece comes up to heat, a soaking period of from 5 to 10 or more seconds can be obtained. No. 3 one-electrode Berwick metal heater for heating stock from ¼ to 1 in., giving any length of heat desired from 1 to 24 in. on the end of bar or at any point in any length bar. This heater will be used in conjunction with the National Machinery Co.'s 1 in. upsetting machine for making upsets.
In attendance: F. C. Cheston, sales agent; Harold Cheston, sales agent; and A. G. Wood, sales agent.

American Cyanamid & Chemical Corp., New York.—Booth G-12.
Exhibiting: "Aerocase Case" hardening compounds, used for case hardening, heat treating and carburizing.
In attendance: P. E. Holder, G. D. Johnston, R. H. Landis, H. H. Suddard, M. J. Wixson, and C. Byron.

American Gas Association, New York.—Booth H-21.
No display of equipment. The equipment display will be taken care of by the various manufacturers who will occupy adjacent booths and who are cooperating with the American Gas Association.
In attendance: H. F. Rehfeldt and Wm. H. Zuse, from the Industrial Gas Sales Dept., of The Peoples Gas Light & Coke Co.

American Gas Furnace Co., Elizabeth, N. J.—Booth I-23.
Exhibiting (in operation): A continuous rotary retort carburizing machine and automatic quenching tank. This equipment may also be used for clean, scale-free harden-



The right alloy

—in the right place, right form, and right quantity means...

better joints—lower costs

Conventional methods of applying heat and feeding brazing alloys by hand often have serious drawbacks in quantity production. Control of heat, time, amount of material used and the all around quality of the joint are left mainly to the skill of the workman.

Some of these variables may be controlled and results improved by using—

THE RIGHT ALLOY—not only the one which has the required physical qualities but preferably an alloy of low melting point—to save time and gas; also to prevent damage to the metals being joined.

IN THE RIGHT PLACE—pre-formed shapes assure placing the alloy so that there is proper flow into the joint without waste.

THE RIGHT FORM—assures correct distribution to all parts of the joint.

THE RIGHT QUANTITY—gives better and more uniform joints—enough material without waste—reduces cleaning costs and improves appearances.

Send us details and, if practical, sample parts. We will be glad to make an engineering study of your problems and offer suggestions. If you prefer to have an engineer call and go over your brazing operations with you, let us know—Write today.

SIL-FOS and EASY-FLO Brazing Alloys "HANDY" Silver Solders

Will be exhibited at the National Metal Exposition in Chicago. If you attend see our demonstrations of joining copper, brass, bronze, steel, stainless steels, nickel, Monel Metal and other alloys—See how effective HANDY FLUX is too.

HANDY AND HARMAN 82 Fulton St., New York

SEE THE J&L STEEL AT THE NATIONAL

J&L STEEL

SPACE C11 AND D11

Jones & Laughlin cordially invites all delegates and visitors to the National Metal Congress and Exposition to see its exhibits of J & L Steel products in Spaces C-11 and D-11. In this exhibit you will see not only samples of Jones & Laughlin products, but interesting examples of the work for which different manufacturers are using them.

JONES & LAUGHLIN STEEL CORPORATION
AMERICAN IRON AND STEEL WORKS
JONES & LAUGHLIN BUILDING, PITTSBURGH, PENNSYLVANIA

Sales Offices: Atlanta Boston Buffalo Chicago Cincinnati Cleveland Dallas Denver Detroit Erie Los Angeles Memphis Milwaukee Minneapolis New Orleans New York Philadelphia Pittsburgh St. Louis San Francisco
Warehouses: CHICAGO CINCINNATI DETROIT MEMPHIS NEW ORLEANS PITTSBURGH
Canadian Representatives: JONES & LAUGHLIN STEEL PRODUCTS COMPANY, Pittsburgh, Pa., U. S. A., and Toronto, Ont., Canada

EXHIBIT
METAL EXPOSITION

CHICAGO
SEPT. 30 – OCT. 4

* * *

J & L exhibits which will be of particular interest to members of the American Society for Metals and of the Societies associated with it in the National Metal Congress are the following:

JALCASE STEEL
Available in .10/.20, .25/.35 and .30/.40 carbon grades. Exhibit shows sample bars of Hot Rolled and Cold Finished Jalcase, test specimens and examples of the work for which Jalcase is being used.

IMPROVED BESSEMER SCREW STEEL
Available in SAE-1112 and SAE-X1112 grades, and supplied in hot rolled bars, cold finished bars and in drawn wire. Exhibit shows sample bars as well as typical examples of the use of Improved Bessemer Screw Steel.

FORGING STEEL
Forging steel of highest quality, produced under strict metallurgical control and rolled on Jones & Laughlin's newest bar mill. Exhibit shows typical parts made of J & L Forging Steel.

COLD HEADING WIRE
Cold heading wire with high quality assured through the painstaking care which Jones & Laughlin devotes to all the factors entering into its manufacture. Exhibit shows a number of examples of the work for which manufacturers are using J & L Cold Heading Wire.

STANDARD SPRING WIRE
Spring wire with the resilience to give just the right springiness and the stamina to hold that springiness indefinitely. Exhibit shows a wide variety of springs made of J & L Standard Spring Wire.

COLD FINISHED SHAFTING
Turned and Ground, Turned and Polished and Cold Drawn. Exhibit shows samples of J & L Turned and Ground Shafting in four sizes.

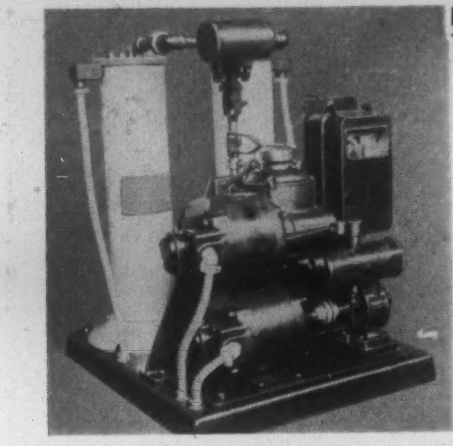
TIN PLATE AND BLACK SHEETS (Tin Mill Sizes)
Including Jalcold Quality
Exhibit shows J & L Coke Tin Plate and Black Plate in various finishes.

HOT ROLLED BARS AND SHAPES
Exhibit shows a number of samples of J & L bars and shapes.

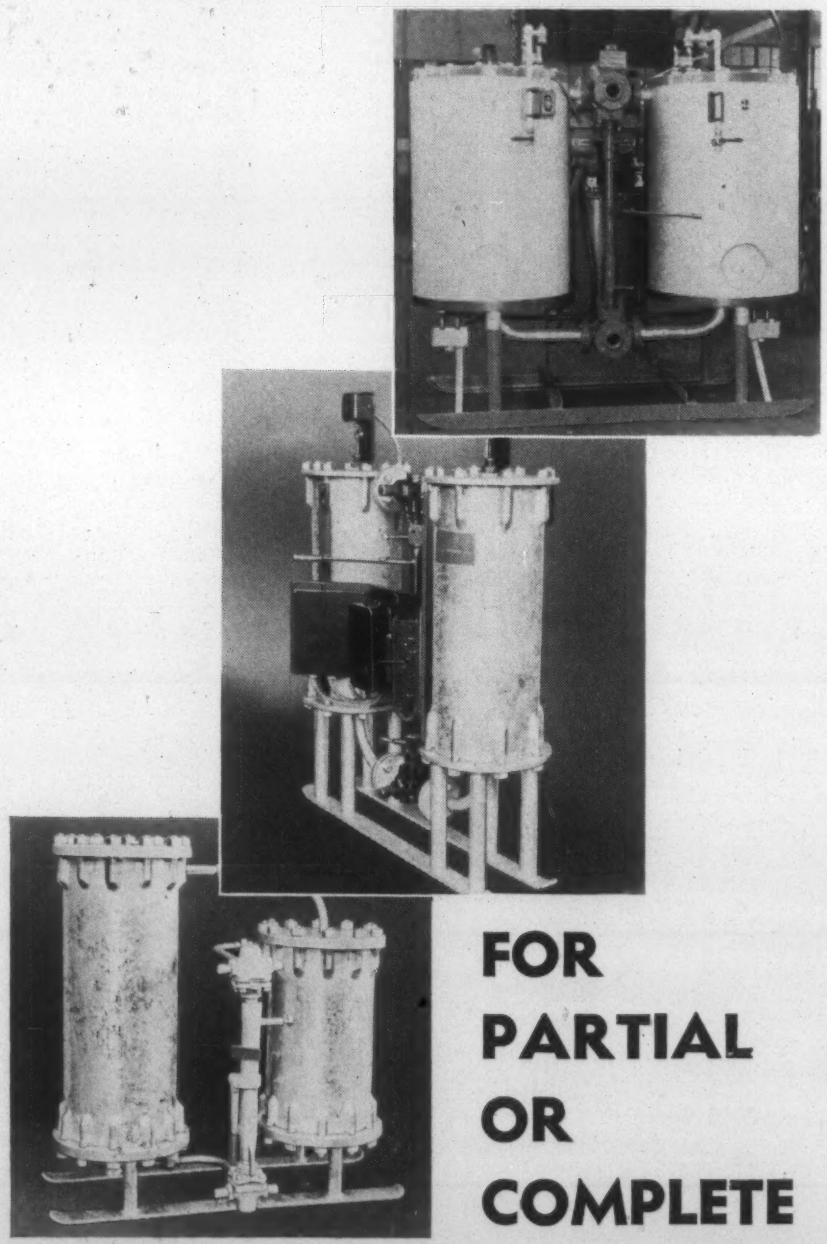
COLD FINISHED BARS AND SHAPES
Exhibit shows a number of samples of J & L cold finished bars and shapes.

Technical Literature

Technical Literature covering all the J & L products on display will be available at the J & L Exhibit, Spaces C-11 and D-11.



INVESTIGATE THE
LECTRODRYER
FOR USE WITH
CONTROLLED ATMOSPHERE PRODUCERS



FOR
PARTIAL
OR
COMPLETE
DRYING OF GASES
WRITE FOR INFORMATION
PITTSBURGH LECTRODRYER CORPORATION
Foot 32nd Street Pittsburgh, Pa.

ing with any desired atmosphere. A full muffle type reciprocating hearth heating machine for treating work in a gaseous atmosphere, including clean, scale-free hardening without decarburization, annealing, etc. A rotary retort carburizing machine showing our latest improvements for carburizing, "Ni-Carbing," nitriding, hardening and annealing. A Bell type retort furnace for carburizing, hardening, nitriding, or our new process of "Ni-carbing." Oven furnaces of various sizes and types incorporating latest features in construction, with linings or insulating refractory, single valve ratio control, etc.; also oven furnace showing our new developments in over firing and bottom venting for maximum economy in operation, minimum heating up time, longer furnace life and elimination of the chimney action which occurs in the ordinary under fired ovens. This high speed furnace is also provided with our auxiliary burner for creating conditions as desired in the heating chamber. A modern pot furnace. Burners of various kinds and styles and high heat melter.

In attendance: P. C. Osterman, vice-president; E. C. Cook, sales manager; John Mehrman, special representative; Theodore Farwick, Sr., burner expert; George A. F. Machlet, sales department; William J. Barenscheer, Chicago representative; O. T. Muehlemeyer, Rockford representative; and S. C. Dinsmore, Detroit representative.

American Hard Rubber Co., New York.—Booth L-11.

American Machine & Foundry Co., Brooklyn, N. Y.—Booth M-24.

American Manganese Steel Co., Chicago Heights, Ill.—Booth O-27.

Exhibiting: Heat and corrosion resistant castings; manganese steel castings; manganese steel welding rod; and hard surfacing welding rod.

In attendance: W. M. Black, general sales manager; W. G. Hoffman, assistant general sales manager; E. F. Mitchell, representative; E. A. Lerner, representative; E. Cook, metallurgist; H. Avery, assistant metallurgist; J. B. Terbell, representative; E. J. Nist, representative; E. L. Quinn, welding engineer; and W. A. Henderson, chief engineer.

American Metal Market, New York.—Booth A-35.

Exhibiting: The pioneer daily newspaper of the iron, steel and metal working industries. Established in 1882 as a weekly, published daily since 1899. Publishing daily market reports, prices, and new developments affecting the iron, steel and metal fields.

In attendance: C. S. J. Trench, editor; E. K. Browne, associate editor; S. P. Trench, vice-president; R. A. Langer, secretary; and S. Glassford, circulation manager.

The American Rolling Mill Co., Middletown, Ohio.—Booth O-23.

Exhibiting (in operation): An interesting, 8-ft. high background, studded with photo-enlargements of mill scenes and plant operations, set in frames, indirectly lighted and centered with oil painting depicting "Armco Spirit." Above background will be hung two signs: one 5 ft. by 18 in. neon of porcelain enamel trimmed with stainless steel, and one fabricated stainless steel sign. At one end of booth a 6-faced cylinder, 5 ft. in dia., will revolve, displaying sample sheets and the standard applications and uses of each sample; at the other end will rest a table display of fabricated products demonstrating the application of our various qualities of stainless. In the center, on the floor, or suspended as a part of the background will be a large sheet of highly polished stainless, 84 x 84 in.

In attendance: J. P. Butterfield, manager stainless steel department; R. C. Cunningham, salesman; and D. C. O'Brien, sales development department.

American Sheet & Tin Plate Co., Pittsburgh (United States Steel Corp. Subsidiary).—Booth E-16.

Exhibiting: See "United States Steel Corporation Subsidiaries."

In attendance: D. T. Haddock, and Karl E. Luger.

American Steel & Wire Co., Cleveland (United States Steel Corp. Subsidiary)—Booth E-16.

Exhibiting: See "United States Steel Corporation Subsidiaries."

In attendance: D. A. Merriman, H. A. Squibbs, M. W. Floto, J. W. Patterson, E. E. Louis, W. H. Cordes, F. Connell, John Graham, A. J. Hess, E. S. Humphrys, C. J. McGregor, H. B. Maguire, P. B. Gilroy, I. Rosenblum,

J. R. Dixon, W. J. Diekmann, P. M. Jones, W. J. Blaser, L. S. Young, and A. E. Ward.

Armstrong-Blum Mfg. Co., Chicago.—Booth K-29.
Exhibiting (in operation): A full line of metal sawing machines of all capacities from 4 to 18 in.; fully automatic production saws, equipped with automatic bar push-up; fully universal metal band sawing machine for tool-room and manufacturing work. "Marvel" high-speed-edge non-breakable hack saw blades, for both power machine and hand use. Improved, new type heavy duty "Marvel" hand hack saw frames. "Marvel" high-speed edge hole saws. A complete new line of "Marvel" horizontal friction tapping machines, shown for the first time at this exposition. A concerted effort is being made to complete the first "No. 18 Marvel Hydraulic" hack sawing machine of 18 x 18 ins. capacity; and if completed, will be shown in operation at this exposition, for the first time. This new, exceptionally heavy and sturdy machine, will embody entirely new principles of blade reciprocation and low-pressure simplified hydraulics, which inventions "we believe will effect new high standards of efficiency in large capacity reciprocating saws, heretofore lacking in all designs."

In attendance: Harry J. Blum, secretary; Gustav M. Hess, salesman; Fred J. Blum, Jr., salesman; and George J. Blum, president.

Armstrong Cork Products Co., Lancaster, Pa.—Booth L-35.
Exhibiting: Two new bricks, recently added to the line of high temperature products. One of the new bricks is known as "Armstrong's EF-26" and this product is an insulating fire brick for direct exposures up to 2600 deg. F. No fire brick protection is required, except when the brick is exposed to the direct impingement of flame or slagging action. This is claimed to permit the use of thinner walls, with a consequent sharper furnace, shorter heating time, speedier production lines, and a real saving on fuel costs. This brick is suitable for all types of furnaces—gas, oil, coal, or electric-operated. The other new brick is "Armstrong's N-20," an insulating brick for use where the temperature back of the refractory does not exceed 2000 deg. F. on the hot face of the brick. In addition to these new products, "Armstrong's EF-22," another insulating fire brick, and "Armstrong's N-16" and "A-25," insulating brick, also will be shown.

In attendance: J. L. Allison, Jr., head of the high temperature insulation department; S. M. Jenkins, New York; L. W. Bertelsen, Pittsburgh; H. H. Gates, Detroit and T. E. Ventriss, Chicago.

Aurora Metal Co., Aurora, Ill.—Booth E-11.
Exhibiting: Auromet die cast bronze parts for printing presses, outboard motors, ironing machines, power lawn mowers, counting machines, variable speed mechanisms, dish washing machines, electric switches, hose couplings, catenary hardware, spray guns, telephone equipment, electric hand saws and sanders, gasoline meters, milk bottle capping machines, machine guns, dump trucks, automobile hardware, automotive maintenance appliances, speed recording apparatus, counting machines, etc. Die cast aluminum bronze gear and worm blanks. Die cast silicon bronze enclosed type centrifugal pump impellers.

In attendance: G. Thurnauer, president; John LeMay, vice-president and chief engineer; A. W. Lauder, vice-president and general manager; R. D. Holmsten, assistant chief engineer; W. D. Rennolds, Chicago; K. B. Spaulding, Detroit; P. Klieber, Indianapolis; and N. C. Failor, New York.

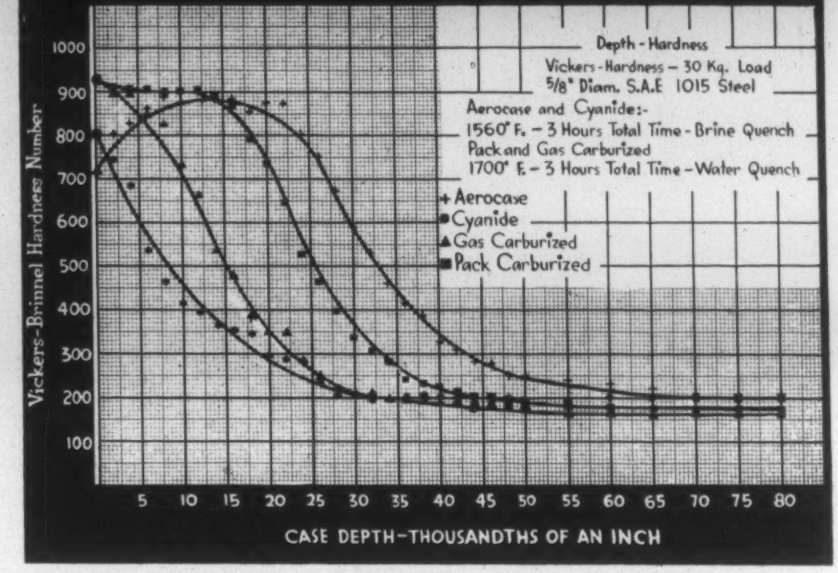
The Babcock & Wilcox Co., New York.—Booth G-11.
Exhibiting (in operation): An animated display showing the savings effected through the installation of B&W insulating firebrick in practically every type of industrial furnace . . . savings as substantial as 84 per cent of former operating costs.

Illustrated charts of the results of the demonstration conducted at the exposition showing how these savings are effected. This demonstration consisted of operating two gas-fired industrial furnaces, one lined with firebrick, and the other with "B&W K-30" insulating firebrick.

The time and fuel readings for these furnaces as recorded by pyrometers and fuel meters have been plotted to show the substantial reductions in heating-up time and in fuel consumption secured by this unusual refractory.

Reports giving the amount of savings in actual in-

INVESTIGATE AEROCASE
for Rapid and Uniform
CASE HARDENING and HEAT TREATING



Do your plans for New Equipment—
or revamping of present case-hardening or heat treating departments
Meet These Tests?

CYANAMID PRODUCTS

1. Will this investment pay me?
Could I equip with a smaller investment and not sacrifice the quality of my product? Does it provide for curtailed production with corresponding decrease in operating expense?

2. Will this equipment give me low production costs?
Will I get low fuel consumption, low equipment depreciation, faster heating up period?

3. Will the case be uniform in depth and hardness?

4. Will the work be free from scale?
Are the parts protected against oxidation when transferring from furnace to quench tanks?

By using *Aerocase Case Hardening Compounds in the new and improved type of furnace, you have the answer to these questions.

*Aerocase Case Hardening Compounds offer the maximum in speed, economy, uniformity and simplicity.

*Write for booklet describing the *Aerocase Case Hardening Process and its applications or request one of our Metallurgists to call and assist you with your case hardening and heat treating problems.*

CHICAGO
BOOTH
G-12
EXPOSITION

*Aerocase—Registered Trade Mark

AMERICAN CYANAMID & CHEMICAL CORPORATION
30 Rockefeller Plaza ● New York, N. Y.

YOLOY

YOLOY TRADE MARK YOUNGSTOWN STEEL

THE SPECIAL PROBLEM STEEL

YOLOY Is a series of steels.....(nickel-copper).....exactly fitted to meet hundreds of new requirements and solve those special problems of modern design where added performance is essential.

AN EXCLUSIVE YOUNGSTOWN PRODUCT

EXCEPTIONAL RESISTANCE TO CORROSION AND ABRASION INCREASED TENSILE STRENGTH AND HIGHER DUCTILITY

● YOLOY possesses a corrosion-resistance four to six times as great as that of ordinary carbon steels. Its resistance to abrasion is pronounced. As compared with carbon steels of the same tensile strength, YOLOY has the same density and hardness. Its endurance ratio, impact resistance, yield point and ductility are greater.

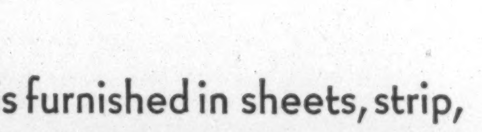
YOLOY, at a lower ultimate cost than for ordinary carbon steels, permits lighter construction with equal strength or greater strength and longer life with the same weight. It is easily hot or cold formed, and lends itself exceptionally well to arc and acetylene welding and to riveting.

YOLOY hot-rolled products have an excellent surface finish characterized by a thin, tight, hard scale, resistant to atmospheric action and abrasion.

YOLOY is furnished in sheets, strip, plates, bars, shapes, wire, seamless and electric weld pipe. The facilities of our Research Department for the proper application of YOLOY are at your service.

Write for the latest
YOLOY bulletin,
shown at right,
which will give you
the complete
YOLOY story.

544



THE YOUNGSTOWN SHEET AND TUBE COMPANY
Manufacturers of Carbon and Alloy Steels
General Offices . . . . . . YOUNGSTOWN, OHIO

stallations will be available, as well as information in panel wall, suspended arch, and other forms of construction. Data on "B&W 80 Firebrick," "B&W Junior Firebrick," and "B&W Mortars and Plastics," too, will be available.

In attendance: J. E. Brinckerhoff, sales manager; R. M. Onan, H. J. Shaner, W. A. Stuart, and F. B. Cornell, salesmen.

Baldwin-Southwark Corp., Philadelphia.—Booth L-19.

Exhibiting (in operation): A 60,000 lb. Southwark-Emery universal testing machine, Southwark-Templin stress-strain recorder, and Carpenter torsion impact machine.

In attendance: F. G. Tatnall, manager testing machine division; F. Buckingham, sales engineer; C. H. Gibbons, development engineer; A. K. Nowak, manager Chicago district office.

Barrett-Cravens Co., Chicago.—Booth N-42.

Exhibiting: A Barrett lift-truck of the single stroke type—model J-630; one of the new Barrett "Speed Boy" lift trucks; a Barrett portable elevator, and a Barrett "Steeleg Platform."

In attendance: E. J. Heimer, vice-president; C. F. Tonne, assistant sales manager; G. M. Lillig and W. L. Hutton.

The Bastian Blessing Co., Chicago.—Booth K-34.

Exhibiting (in operation): "Rego" gas welding and cutting equipment as used on high speed production welding operations. Valuable free prizes will be given for the closest estimate of the number of parts welded each day. Additional demonstrations of various miscellaneous welding and cutting operations using both oxy-acetylene and oxy-propane flames will be made. A complete line of "Rego" welding and cutting equipment will be on display.

In attendance: E. L. Mills, vice-president; H. A. Goodwin, district manager; H. O. T. Ridlon, district manager; and E. M. Evleth, engineer.

Bausch & Lomb Optical Co., Rochester, N. Y.—Booth A-27.

Bell & Gossett Co., Chicago.—Booth J-7.

The Bellis Heat Treating Co., Branford, Conn.—Booth M-18.

Exhibiting (in operation): Electrically operated "Lavite" furnace for bright annealing, heat treating and hardening as applied to wire, stampings, tools of steel, gold, nickel, copper and brass.

In attendance: A. E. Bellis, president; and W. J. Holcomb, sales manager.

Bethlehem Steel Co., Bethlehem, Pa.—Booth C-15.

Exhibiting (in operation): A working model of our wheel heat treatment department which will show mechanically the wheel being charged into the heat-treating furnace, withdrawn from this furnace and placed in the quencher, then taken from the quencher and placed in the annealing furnace, and finally withdrawn from this furnace and placed into the cooling pit. (The model will be very closely similar in operation to the actual unit in the plant—this being accomplished by the use of lighting and mechanical effects).

Large transparencies showing steps in the manufacture and heat treatment of wheels, also large transparencies showing heat treatment of large forgings.

A working model of our bar electric heat treatment department showing mechanically the bars being charged into the pre-heating furnace, transferred to the high temperature furnace, and from this furnace moved on to the crane which picks them up and carries them to the quenching tank, quenched and finally placed on the discharging rack.

Corrosion-resisting steel: Display of a variety of products made from various grades of "Bethadur" and "Bethalon" steels.

"Bethanized" wire: Display of various types of fence, springs, barbed wire, etc., made from "Bethanized" wire.

Alloy bolting material: Display of specialties, high pressure screws, alloy studs, heat-treated and oil-quenched nuts, etc.

Small tool products such as shear blades, chisel blanks, rivet sets, etc.

In attendance: G. F. Hocker, manager of sales, forgings, castings, wheels, etc.; E. A. Buxton, manager of sales, tool steel and small tools; D. A. St. Clair, salesman, tool steel and small tools; A. K. Boot, salesman, wheels and axles; F. H. Baldwin, salesman, hardened steel rolls; Ralph Symons, salesman, wire; E. H. Gumbart, salesman, alloy steels; Chicago Sales Representatives: E. F. Kinny, metallurgical engineer; W. R. Shimer, metallurigal engineer; H. Wysor, metallurgical engineer; P. E. McKinney, metallurgical engineer; L. H. Winkler, metallurgical engineer; A. P. Spooner, assistant metallurical engineer; T. D. Shannahan, research metallurgist; E. Gurney, contact man; P. E. Penrod, engineer of tests, Cambria Plant; S. B. Leonard, contact man; S. H. Yorks, advertising department; and A. A. Warg, advertising department.

G. S. Blakeslee & Co., Chicago.—Booth K-34.

Bristol Co., Waterbury, Conn.—Booth G-4.

The Brown Instrument Co., Division of Minneapolis-Honeywell Regulator Co., Philadelphia.—Booth J-15.

Exhibiting (in operation): This combined exhibit will include indicating and recording instruments and automatic control equipment for the production, fabrication and heat treatment of metals. Several models of the new "Brown Air-O-Line" controllers will be shown. Other Brown instruments to be exhibited are single and multiple recording control potentiometers with signal and excessive furnace temperature cut-off safety switches, recording and multiple control thermometers, mechanical and electric flow meters and electric CO_2 recorders. The new "Optimatic" pyrometer will also be exhibited. This is a high-speed automatic optical pyrometer for recording rapidly changing temperatures or the temperatures of moving objects such as rails, sheets, bars and structural shapes while they are being rolled. In addition, this exhibit will include the Minneapolis-Honeywell proportioning control system, "Protectoglof" combustion safeguard system, and several new M.-H. electrically operated control valves with adjustable orifices and flow ratios.

In attendance: J. H. Green, manager, steel and ceramic division, Brown Instrument Co.; R. H. Goetzenberger, sales manager, industrial division, Minneapolis-Honeywell Regulator Co.; C. H. Saunders, district manager, Chicago office; H. M. Schmitt, publicity and market development department, Philadelphia; R. A. West, sales engineer, Chicago; C. L. White, sales engineer, Chicago; I. K. Farley, sales engineer, Milwaukee; R. G. Taylor, sales engineer, Chicago; J. Kelley, sales engineer, Detroit; and C. Lugar, sales engineer, Cleveland.

Burdett Mfg. Co., Chicago.—Booth H-26.

Exhibiting (in operation): Burdett radiant heat gas burners producing directed and controlled radiant heat, operating under full automatic control. The equipment will be so arranged that it can be operated manually as well, using "Burdett Turndown and Proportional Mixing" valve. The different sizes and types of burners will be on display. The new Burdett automatic self-relighting pilot and mechanical auxiliary flare will be on demonstration.

In attendance: James A. Lytle, vice-president and general manager; T. Tesmer, superintendent; J. E. Orr, special representative; C. E. Petersen, special representative; and S. V. Kay, special representative.

Andrew C. Campbell, Division American Chain Co., Bridgeport, Conn.—Booth F-9.

Carboloy Co., Inc., Detroit.—Booth J-3.

Exhibiting: Carboloy drawing and extrusion dies, Carboloy cemented carbide cutting tools and Carboloy diamond impregnated wheel dressers.

In attendance: W. S. Baker, K. R. Beardslee, P. O. Deeds, A. F. Dobbrodt, W. W. Fullager, J. R. Longwell, E. C. Howell and W. G. Robbins.

The Carborundum Co., Niagara Falls, N. Y.—Booth C-9.

Carnegie Steel Co., Pittsburgh (United States Steel Corp. Subsidiary).—Booth E-16.

Exhibiting: See "United States Steel Corporation Subsidiaries."

In attendance: J. Halsey McKown, E. T. Barron, F. T. Bumbaugh, P. Schane, Jr., J. T. Ross, C. G. Purnell, R. Simon, T. S. Woodward, C. F. W. Rys.

The Carpenter Steel Co., Reading, Penn.—Booth C-20.

Exhibiting (in operation): Will dramatize the new Matched Set Method of selecting the proper tool steel for making all kinds of tools. By means of a simple diagram, a tool maker can, of his own knowledge, select the proper tool steel for new tools or correct his troubles with old ones. The Carpenter Torsion Impact Machine for measuring the toughness of hardened tool steel will be on display in operation.

Carpenter Stainless Steels and their applications will complete the exhibit.

In attendance: F. A. Bigelow, president; J. H. Parker, vice-president; F. R. Palmer, assistant to the president; B. H. Delong, metallurgist; G. V. Luerssen, metallurgical department; O. V. Greene, metallurgical department; Geo. H. Edmonds, exhibit manager; John B. Guthrie, Chicago sales manager; E. E. Mueller, sales department; L. E. Cooney, sales department; C. W. Windfelder, sales department; J. L. Hall, sales department; R. I. Beeson, sales department; and Leroy Owen, sales department.

The Case Hardening Service Co., Cleveland.—Booth J-7.

Exhibiting: "Non-Case Anticarburizing Paint." This product has been in consistently increasing use for ten years with no selling effort and no advertising publicity given it. Each year new customers have become repeat users, apparently learning of its value from other consumers. It is evident that "Non-Case" meets a requirement which is not satisfied by other products or methods, and that many manufacturers will find it helpful when it is brought to their attention. "Non-Case" is ready for use as shipped. It is applied by dipping or with a soft brush. After drying, the case-hardening is done as usual, but the area coated will not absorb carbon. It can be applied to spots on shafts or spindles that are to be drilled or machined after hardening. It can be used to leave soft sections for straightening after shafts are hardened, or for obtaining soft ends, hubs or threads. When the work is quenched, "Non-Case" comes off readily, leaving a clean surface.

Also a complete line of materials and equipment for the heat-treating department.

In attendance: W. C. Bell, president; E. J. Gossett, vice-president; J. S. Ayling, sales manager; C. P. Critzer, sales engineer.

The Chapman Valve Mfg. Co., Indian Orchard, Mass.—Booth A-32.

Exhibiting: A complete setup showing the operation of the "Chapmanizing" process. Also metallurgical information showing the results obtained by the use of this process.

In attendance: R. E. Tower, Chicago representative; J. H. Keegan, and V. T. Malcolm, director of research.

Chicago Eye Shield Co., Chicago.—Booth N-4.

Chicago Steel Foundry Co., Chicago.—Booth K-28.

Chicago Tool & Engineering Co., Chicago.—Booth L-23.

Climax Molybdenum Co., New York.—Booth K-41.

Exhibiting: A number of parts fabricated from different molybdenum alloy steels and cast irons chosen to illustrate the application of the alloy to the modern ferrous metal industry. The samples will be classified under five major fabricating processes: Carburizing, welding, forging, heat treating and machining.

In attendance: Max Schott, president; J. B. Thorpe, vice-president; Alan Kissock, vice-president in charge of production; W. P. Woodside, vice-president in charge of research; A. J. Herzig, chief metallurgist; V. A. Crosby, foundry metallurgist; and the following metallurgical engineers: C. M. Loeb, Jr., P. M. Snyder, E. R. Young, G. O. Loeffler, T. W. Hardy, E. H. Kottnauer, T. D. Parker.

Colonial Broach Co., Detroit.—Booth I-3.

Columbia Steel Co., San Francisco (United States Steel Corp. Subsidiary).—Booth E-16.

Exhibiting: See "United States Steel Corporation Subsidiaries."

Columbia Tool Steel Co., Chicago Heights, Ill.—Booth F-15.

Exhibiting (in operation): Tools and specimens of "Clarite" high-speed, "Vanite" high-speed, "Maxie Super" high speed, "Superdie" high carbon-high chromium, "Oildie" non-shrinking, "Uni-die" oil hardening, "Buster" punch and chisel, special, extra and standard tool steel.

In attendance: Thomas G. Dougall, Chicago district sales manager; T. L. Haines, S. A. Maurin, S. F. Evans; C. F. Scheid, Milwaukee district sales manager; A. W. Mierow;

TWO in ONE

PREPARED ATMOSPHERE

FURNACE FUEL

Propane or Butane do both jobs

Liquefied petroleum gas, either Propane or Butane, can do double duty in your plant—firing your furnaces and permitting the production of prepared atmospheres. Why bother with special or expensive gases for atmospheres when either of these fuels gives you a low-cost, readily available, exceptionally pure hydrocarbon fuel, uniform in composition and gravity, and suitable for every heating operation!

You can use this modern industrial gas no matter where your plant is located. Investigate its economies today. Complete information will be furnished on request.

Philgas
DEPARTMENT
PHILLIPS PETROLEUM COMPANY
GENERAL MOTORS BUILDING
DETROIT, MICHIGAN

What Do You Want in Weld Metal?

IN MILD STEEL? . . . Tensile strength 65,000 to 75,000 lbs. per sq. in.? Ductility 20% to 30% elongation in 2 inches? Fatigue resistance 28,000 to 32,000 lbs. per sq. in.? Impact resistance 50 to 80 ft. lbs. (Izod)? Density 7.82 to 7.86 grams per c. c.? Corrosion resistance greater than the steel itself?—Such welds are made in any position—flat, horizontal, vertical or overhead—with "Fleetweld" electrode.

IN HIGH TENSILE STEEL? . . . Tensile strength 85,000 to 100,000 lbs. per sq. in.? Ductility 15% to 20% elongation in 2 inches? Impact resistance 60 to 75 ft. lbs. (Izod)? Endurance limit 45,000 lbs. per sq. in.? Density 7.82 to 7.86 grams per c. c.? Corrosion resistance equal to the steel welded?—These characteristics are possessed by welds made with *"Shield-Arc 85"* electrode.

IN STAINLESS STEELS? . . . Do you want these characteristics? . . . Tensile strength of 85,000 to 95,000 lbs. per sq. in.? Ductility 50% to 60% elongation in 2 inches? Impact resistance 100 to 120 ft. lbs. (Izod)? Density 7.86 grams per c. c.? Corrosion resistance at least equal to the plate?—Welds made with "Stainweld A" electrode have these characteristics.

FOR RESISTING SHOCK AND ABRASION . . .
For hardness of 30 to 45 Rockwell C, use "Hardweld"
For hardness of 48 to 52 Rockwell C, use "Wearweld"
For hardness of 45 to 60 Rockwell C, use "Abrasoweld"
For hard facing manganese steel, use "Manganweld"
For making high speed cutting edges, use "Toolweld"

● Ask for samples and complete procedures for easy welding with any of the above electrodes.

SEE THESE WELDS MADE
NATIONAL METAL EXPOSITION
CHICAGO BOOTH H-3 Sept. 30 - Oct. 4

THE LINCOLN ELECTRIC COMPANY
Department LL-168 Cleveland, Ohio
Largest Manufacturers of Arc Welding Equipment in the World

Arthur T. Clarage, president; R. M. Sandberg, general manager; C. B. Shoenberger, general superintendent; A. J. Scheid, metallurgist; W. M. Hopkins; G. C. Beebe, Cleveland district sales manager; Alex Luttrell, Detroit district sales manager; F. A. Terry, Cincinnati district sales manager.

Continnental Industrial Engineers, Inc., Chicago.—Booth J-21.

Crown Rheostat & Supply Co., Chicago.—Booth M-19.
Exhibiting (in operation): Plating barrels, polishing lathe, dryer, nickel anodes, automatic polishing equipment, and plating rheostats.
In attendance: Geo. A. Spencer, manager; G. E. Huenerfauth, sales engineer; W. G. Meggers, sales engineer; J. H. Hoefer, sales engineer; and F. P. Green, sales engineer.

Crucible Steel Co. of America, New York.—Booth K-31.
Exhibiting: Various grades of tool steels, non-corrosive steels, agricultural steels and drill steels.
In attendance: A. T. Galbraith, general manager of sales; R. E. Christie, assistant general manager of sales; J. D. White, manager Chicago branch; J. H. Hinkley, J. F. Taylor, A. J. Schatke, A. C. Paulson, C. A. Oehring, C. A. Cooper, J. H. Jones, C. J. Woods, F. A. Coddington, G. T. Fraser, F. T. Connor, J. W. Slattery, H. H. Rickabaugh; and others.

Cyclops Steel Co., Titusville, Pa.—Booth O-19.

Darwin & Milner, Cleveland.—Booth K-14.
Exhibiting: High-carbon high-chromium steels, oil-hardening "Neor" and air-hardening cobalt-chromium steel "PRK-33" and demonstrating increased quantity production thereof. Other exhibits will deal with cobalt alloyed high-speed steels and high grade tool steels in general, welding rods of cobaltcrom "PRK 33" steel, etc.
In attendance: V. F. J. Tlach, president; H. L. Harrison, sales engineer; A. F. Brunck, and R. J. Foley.

Despatch Oven Co., Minneapolis, Minn.—Booth J-13.
Exhibiting: (in operation): A new Despatch convected air tempering and drawing furnace, gas heated, in daily operation, which "embodies all of the patented features of air circulation and recirculation and special gas heating arrangement which assures unusual uniformity in the working chamber, close accurate temperature control, and great operating savings, effecting economies up to 80 per cent." The unit will be arranged for operation at 1200 deg. F. and will be flexible for operation at any point from 300 to 1200 deg. F. Summing up, the Despatch furnace is of the convected air type, gas heated. It is unusually uniform, saves money in operating costs, saves on the initial cost and besides being very flexible saves time due to faster heat transfer to parts.
Besides the heat-treating furnace, there will be numerous photographs of industrial ovens of all kinds.
In attendance: H. L. Grapp, J. H. Hopp, C. L. Stewart, K. J. Papke, F. H. Faber, and A. E. Grapp.

Detroit Tap & Tool Co., Detroit.—Booth I-3.

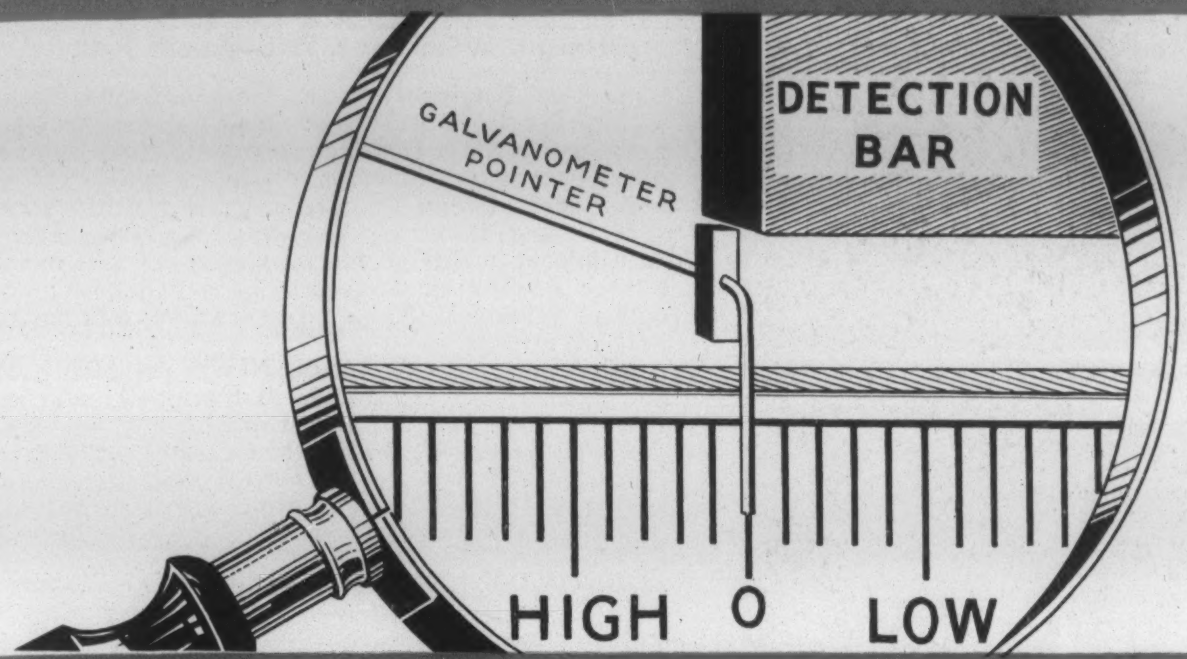
Divine Brothers Co., Utica, N. Y.—Booth M-19.

Joseph Dixon Crucible Co., Jersey City, N. J.—Booth M-29.
Exhibiting: Graphite crucibles, stoppers, greases.
In attendance: R. B. Beam, sales representative; E. C. Bleam, sales representative; and L. F. Bruce, Crucible Sales Department.

The Dow Chemical Co., Midland, Mich.—Booth B-35.
Exhibiting: A complete display of "Dowmetal" parts including sand castings, die castings, forgings, structural shapes, bars, rods, sheet and plate. A large "Dowmetal" cooling pan 7 feet in diameter located in the center of the background.
In attendance: L. B. Grant, manager Dowmetal Sales; Otis Grant, Dowmetal Sales; H. W. Dove, Dowmetal Sales; W. R. Caple, Dowmetal Sales; and W. F. Stumpfig, advertising manager.

Driver-Harris Co., Harrison, N. J.—Booth D-27.
Exhibiting: Heat and corrosion and acid resisting castings for enameling, carburizing, cyaniding, nitriding, normalizing, annealing, glass installations, etc., made of the alloys "Nichrome," "Cimet," and "Chromax" in the form of carburizing boxes, retorts, furnace parts, pyrometer tubes, sheet containers, muffles, enameling racks, welding rods, etc.

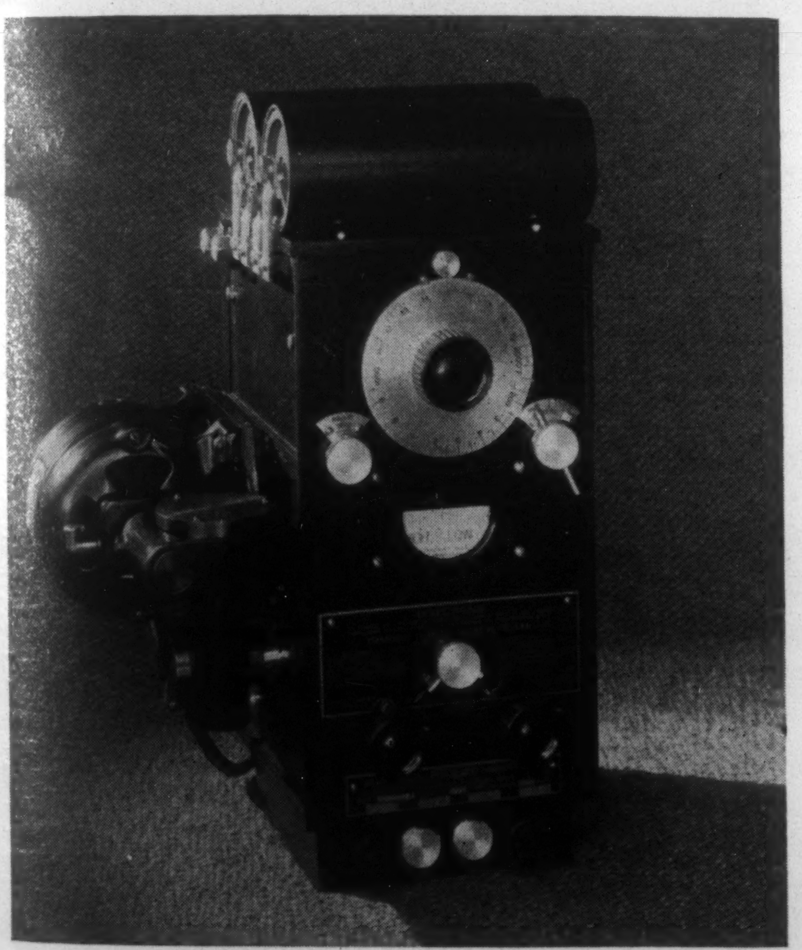
KNIFE-EDGE DETECTION



means *Better Temperature Control*

ON DISPLAY

Iron & Steel Show, Pittsburgh, Sept. 24, 25, 26
Metal Exposition, Chicago, Sept. 30 — Oct. 4



Unaided eyes can't see a movement of 1/1000th or 2/1000th of an inch. But the acutely sensitive Foxboro Potentiometer Controller can detect this small movement *and exert control action accordingly!* When the temperature in your furnace, kiln or retort begins to vary slightly, the galvanometer pointer of the Controller need deflect as little as 1- or 2/1000th of an inch, to cause the instrument to change the valve setting and restore the control temperature.

There is no "dead-spot" in the Foxboro Controller—when the pointer deflects, control action follows. The result is: *close temperature control*—the kind you need for quality heat-treating.

If you are trying to get along with control pyrometers that are out-of-date, inefficient, unreliable—why not replace them with these modern Foxboro Controllers? Investment is surprisingly small—particularly if you can group several Controllers and operate them with one drive unit.

NEW BULLETIN 202
gives full details. Send for your copy.

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54 Neponset Avenue
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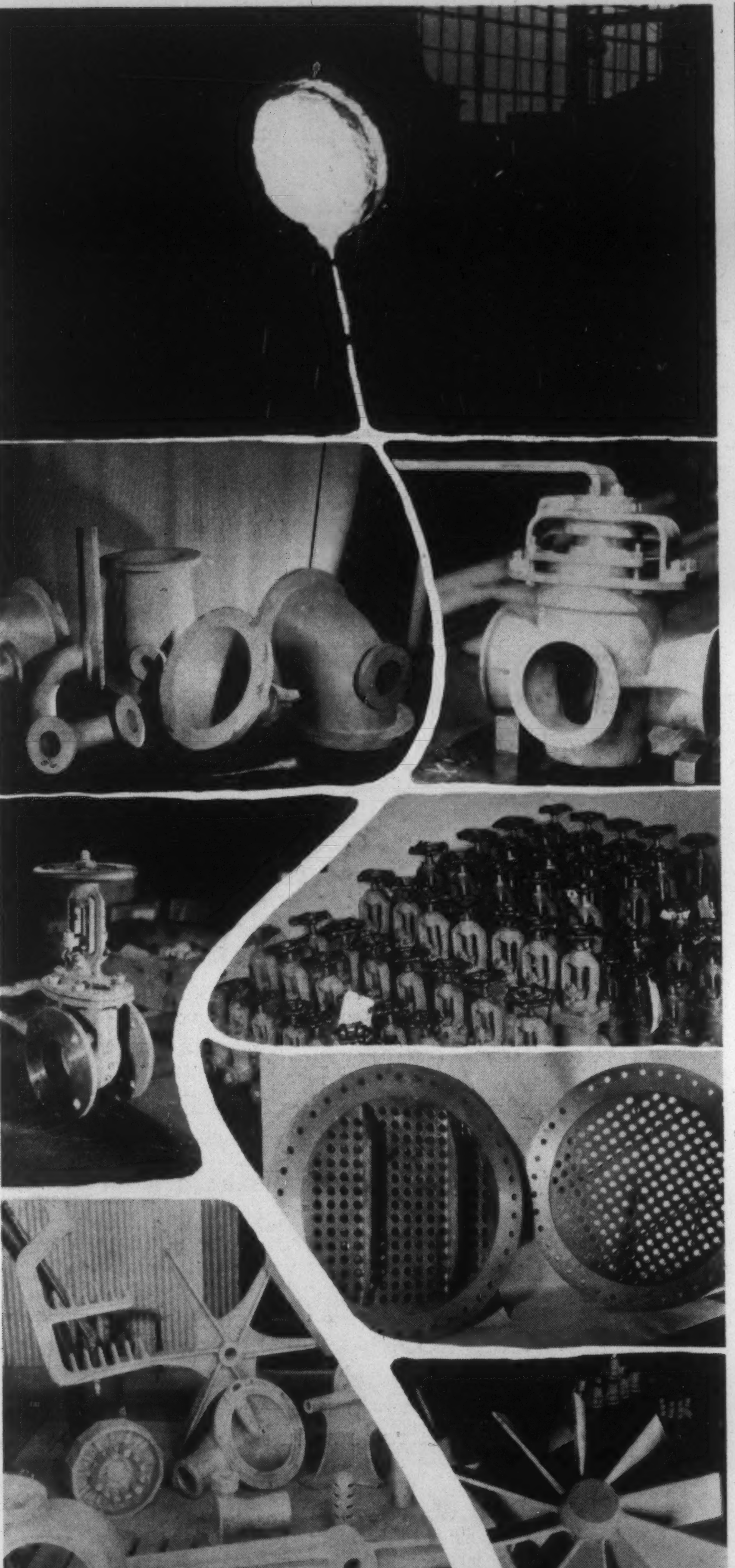
POTENTIOMETERS
- Indicating
- Recording
- Controlling

MILLIVOLTMETERS
- Indicating
- Recording

ELECTRIC RESISTANCE THERMOMETERS
- Indicating
- Recording
- Controlling

FOXBORO
REG. U. S. PAT. OFF.
PYROMETERS
• COMPLETE INDUSTRIAL INSTRUMENTATION •



THE STEADY FLOW of Durco corrosion-resisting Alloy Steel equipment to the Process Industries is lowering costs and improving products in many plants. Durco Alloy Steels might benefit you, too. Why not find out? Just write the Alloy Steel Division,

THE DURIRON CO., Inc.,
432 N. Findlay, Dayton, O.

In attendance: F. V. Lindsey, vice-pres. and gen. sales mgr; G. A. Lennox, asst. gen. sales mgr.; W. E. Blythe, district mgr.; J. B. Shelby, A. J. Eckley, H. M. Thornquist, L. V. Prior, K. H. Hobbie, G. M. Pinney and F. W. Cassey, sales engrs.

E. I. du Pont de Nemours & Co., R. & H. Chemicals Department, Wilmington, Del.—Booth F-32.

Eclipse Fuel Engineering Co., Rockford, Ill.—Booth G-23.
Exhibiting (in operation): Gas-fired heat-treating furnace; gas-fired pot furnace; automatic shop room furnace; No. 60 crucible furnace; 4 H. P. type "D" gas-fired boiler, complete with condensation return system; two special furnace burner displays; four sizes McKee pressure burners; McKee fan type proportional mixer; blast burner display; atmospheric burner display; automatic control valves; McKee dual lock valve; and pressed steel pots of various sizes.

In attendance: G. W. McKee, vice-president; Kurt A. Scharbau, treasurer; Donald A. Campbell, sales engineer; Leo J. Strohmeyer, sales engineer; E. E. Magnuson, sales engineer; F. F. Marlowe, sales engineer; V. P. Palmer, sales engineer; C. H. Martin, district representative; Earl A. Stoner, superintendent; Albert Stadler, superintendent; and H. O. Hoffman, superintendent.

The Electric Furnace Co., Salem, Ohio.—Booth G-8.
Exhibiting: Photographs of new developments in controlled atmosphere furnaces for brazing, scale-free heat treating and bright annealing ferrous and non-ferrous material, including wire, tubing, sheet, strip, stampings, etc. Also, photographs of furnaces for normalizing, carburizing, nitriding, forging, annealing and other heat treating processes. Also, samples of material treated in these furnaces.

In attendance: R. F. Benzinger, vice-president; F. T. Cope, general manager; A. H. Vaughan, chief engineer; T. B. Bechtel, sales engineer; C. L. West, sales engineer; K. U. Wirtz, sales engineer; B. C. Thompson, Detroit district representative; and A. E. Wright, advertising manager.

The Electro-Alloys Co., Elyria, Ohio.—Booth K-15.
Exhibiting: Heat and corrosion resisting castings.

In attendance: H. L. Dixon, metallurgical engineer; W. J. Hansen, representative, eastern territory; J. W. Henry, superintendent; A. M. Miller, Jr., rpresentative, Michigan; J. B. Thomas, treasurer; W. C. Whyte, vice-president; and F. K. Ziegler, metallurgical engineer.

Electro Metallurgical Sales Corp., New York.—Booth I-1.

Ensign-Reynolds, Inc., New York.—Booth G-21.
Exhibiting (in operation): Dual heated immersion type electrotype furnace; rotary type air cooled gas compressor; ribbon burners; screen burners; high pressure gas inspirators; soldering furnace; staylite burners; centrifugal air blower; centrifugal gas blower; atmospheric burners and inspirators; and tentering frame unit.

In attendance: F. J. Fieser, assistant to the vice-president; and N. E. Bertl.

Firth-Sterling Steel Co., McKeesport, Pa.—Booth L-7.

Exhibiting: The latest in improved designed "Firthaloy" sintered carbide dies and tools. Also many tools and wear-resistant parts made of "Firthaloy," which has been developed recently for new applications. Another exhibit will be models of the patented Firth "Winged Ingot." The winged ingot method of casting steel eliminates the entire center of the ingot containing any possible porous structure, leaving only the sound center-free portion of three sections or wings to be forced into billets.

In attendance: D. G. Clark, vice-president; A. B. Corbin, sales manager; O. K. Parmiter met. engineer; A. R. Zapp, Firthaloy division manager; H. W. Elias, Firthaloy engineer; E. T. Jackman, Chicago manager; E. T. Broaddus, sales engineer; C. E. Hughes, sales engineer; Alan Jackman, sales engineer; A. F. Lind, Firthite engineer, and many more representatives.

The J. B. Ford Sales Co., Wyandotte, Mich.—Booth D-31.

Exhibiting: Complete display of "Wyandotte" specialized metal cleaners for plating, lacquering, enameling, japanning, and vitreous enameling. For use in still solutions, electric cleaning solutions, metal parts washing machines, tumbling barrels, and spray gun equipment. For cleaning before bonderizing, anodizing, hot tinning, gal-

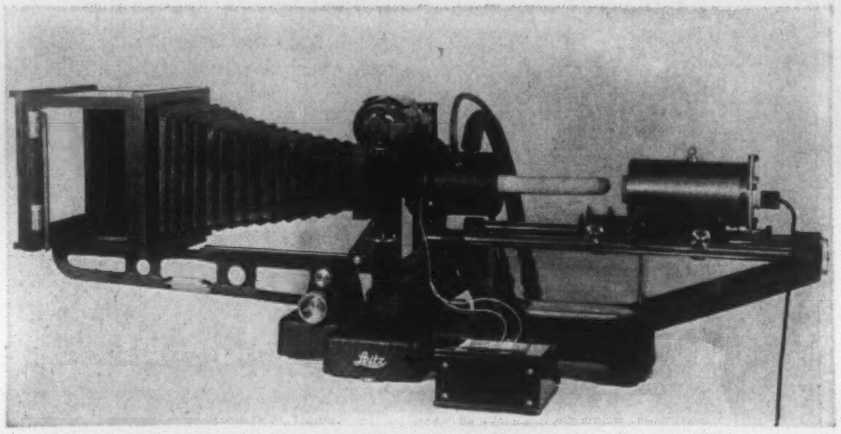
LEITZ EXHIBITS

AT BOOTH L-24

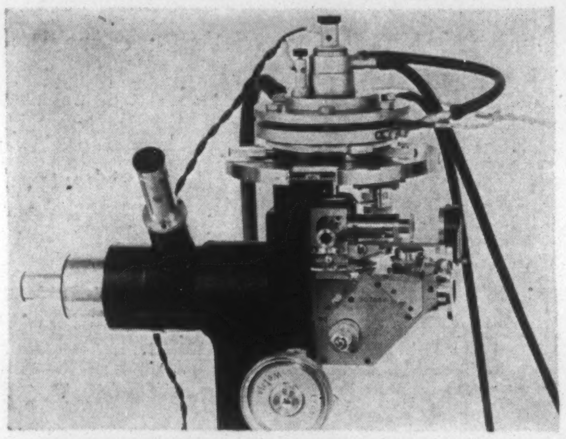
NATIONAL METAL EXPOSITION, CHICAGO, ILLINOIS

SEPTEMBER 30-OCTOBER 4, 1935

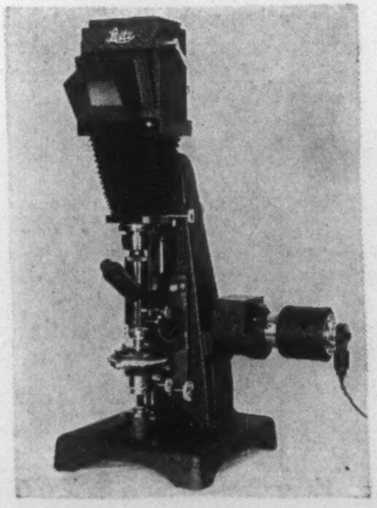
Anticipating tomorrow's demands for equipment of Metallurgical Research Laboratories, we exhibit the following new instruments:



1—A new Automatically Recording Dilatometer. Unique in compactness of design, accuracy of the curves and sensitiveness in recording the minutest changes in metals caused by thermal influences. Especially valuable for determinations of properties of light metals.



2— Vacuum Heating Chamber attachable to latest Leitz Micro Metallograph permitting observations of the micro structures of metal specimens while they are being heated to a maximum temperature of 1150° C.



3—A Universal Microscope with Photographic Camera "PANPHOT" suited for every conceivable task of modern microscopy.

And many other new and valuable instruments for the metallurgist such as 3 of the latest models of Leitz Micro Metallograph, a new greatly improved model of the Guthrie-Leitz Automatic Grinding and Polishing Machine as well as simpler models of metal microscopes and accessories.

Consult our Technical Staff for recommendations and assistance in solving your micro-metallographic and dilatometric problems.

E. LEITZ, Inc.

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CENTRIFUGAL COMPRESSORS

SIMPLE
STURDY
ACCESSIBLE
Sturtevant

The above compressor furnishes air for small furnace, an oil burner and for blowing out waste material in punching machines.

MADE in several types for furnaces, pneumatic conveying and other purposes. ¶ *Pressures:* ½ to 5 lbs. *Volumes:* 50 c.f. to 50,000. ¶ Write for complete data.

B. F. STURTEVANT CO., Hyde Park, Boston, Mass.
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"Alnor"

Indicating Pyrometers

and Distant Reading Thermometers for every Industrial Purpose

Accurate
Durable
Inexpensive

See Exhibit at Booth J11

NATIONAL METAL SHOW
Chicago Sept. 30 to Oct. 4

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Illinois Testing Laboratories, Inc.
425 No. La Salle St. Chicago, Ill.

Manufacturers of "Alnor" and "Price" Pyrometers and Resistance Type Thermometers

Products of 35 Years' Experience

vanizing, and assembling. For removing lacquer, japan, carbonized mineral oils, and fabricating compounds. "Wyandotte" burnishing compounds for all burnishing problems. "Wyandotte" neutralizers for neutralizing acid after pickling operations. "Wyandotte" specialized cleaners for cleaning railway equipment, aeroplane, and automotive equipment.

In attendance: B. N. Goodell, manager industrial department; W. M. Cole, assistant manager industrial department; A. J. Ratz, manager Chicago office; and C. S. Tompkins, industrial department representative, Chicago territory.

The Foxboro Co., Foxboro, Mass.—Booth G-16.

Exhibiting (in operation): "Non-recorder" pressure controller type 2119, "Non-recorder" temperature controller type 1119, potentiometer stabilog, recording temperature stabilog, recording gauge, rotax indicating temperature controller, indicating gauge, indicating thermometer, recording thermometer, indicating liquid level gauge, switches (pyrometer), tapalog recording pyrometer, pyrometer indicators, single record potentiometer recorder, multiple record potentiometer recorder, automatic potentiometer pyro, controllers with group drive, and flow stabilog.

In attendance: J. J. Burnett, Chicago branch office manager; E. R. Huckman, M. A. Schreiner, E. B. Miller, and E. E. Kleir.

The Gathmann Engineering Co., Baltimore.—Booth C-23.

General Alloys Co., Boston.—Booth H-4.

Exhibiting: Nickel-chromium alloys, "Q-Alloys;" carburizing and annealing containers; cyanide and lead pots, furnace hearths, roller rails, heat and acid-resisting chain, cyanide dipping baskets, recuperators, miscellaneous furnace parts, parts for every type heat-treating furnace; carburizing, annealing, normalizing, hardening, tempering, forging, spheroidizing, tubes and retorts; corrosion and abrasion resisting castings; corrosion resisting fittings for marine use.

In attendance: H. H. Harris, president; G. C. McCormick, vice-president; R. D. Alger, superintendent; W. R. Blair, engineer; R. M. Atwater, engineering executive; J. J. Donovan, western manager; E. R. Dougherty, Chicago representative; A. L. Grinnell, manager Detroit office; W. D. Hazleton, Detroit office; R. M. Kirk, manager New York office; Frank W. Ladky, Milwaukee representative; E. J. Boettcher, Milwaukee representative; Edward W. Voss, Pittsburgh representative; and Ralph Hare, New England representative.

General Electric X-Ray Corp., Chicago.—Booth D-32.

The William D. Gibson Co., Chicago.—Booth M-35.

Exhibiting: Springs.

In attendance: E. W. Stewart, vice-president and sales manager; E. C. Spal, assistant sales manager; F. A. Volstorff, E. J. Muehlhausen, and W. A. Peterson, sales representatives.

Globar Corp., Niagara Falls, N. Y.—Booth C-9.

Gogan Machine Co., Cleveland.—Booth M-36.

Claud S. Gordon Co., Chicago.—Booth I-10.

Exhibiting: X-Ray films; pyrometers; and pyrometer accessories, such as tubes, thermocouples, lead wires, insulators, thermocouple heads, and special control equipment.

In attendance: Claud S. Gordon, president; A. W. Anderson, vice-president; S. A. Silbermann, service engineer; and C. O. Anderson, manager Cleveland office.

Grasselli Chemical Co., Inc., Cleveland—Booth E-35.

Great Lakes Steel Corp., Detroit.—Booth C-35.

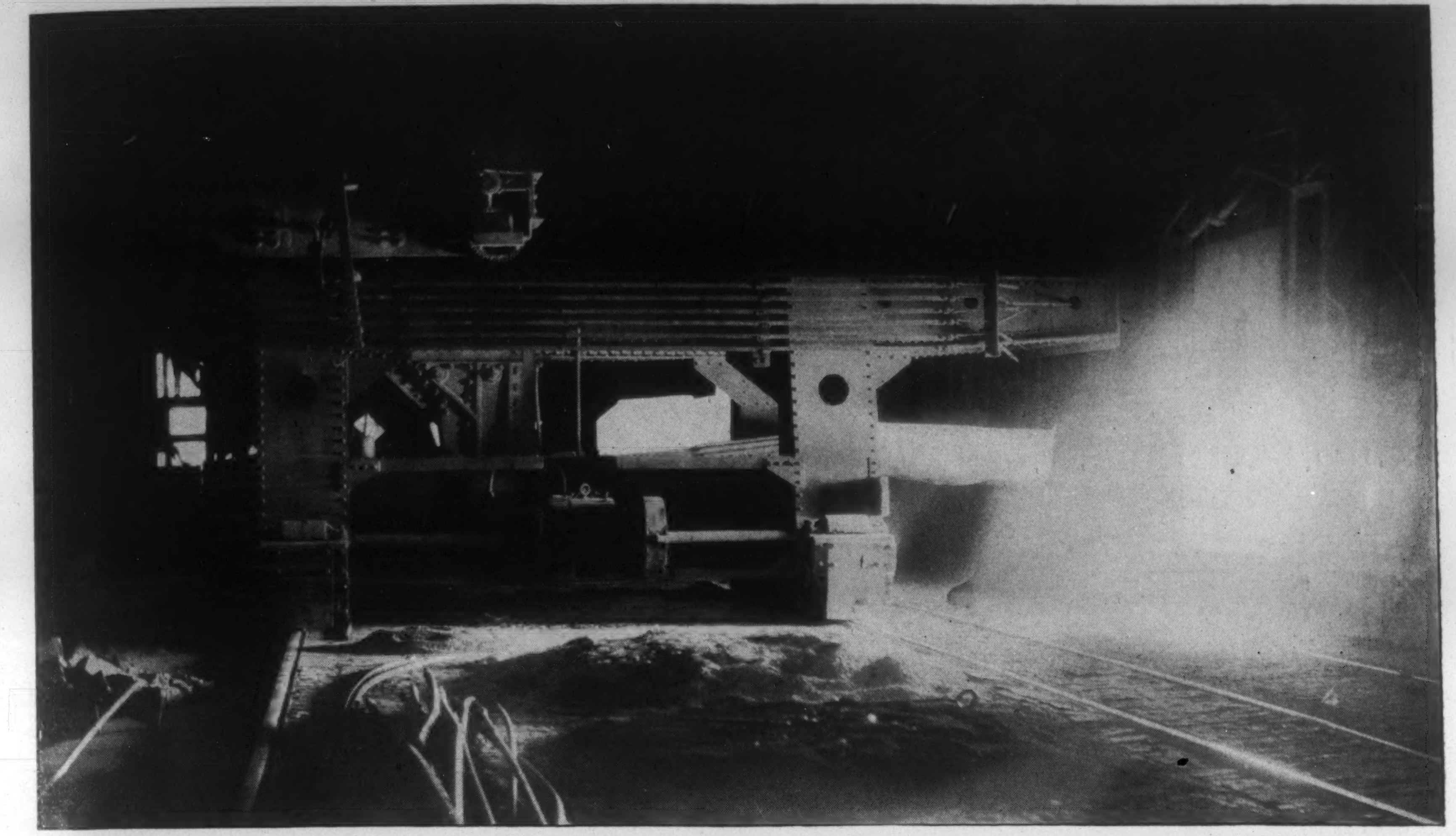
Exhibiting: Automobile steels.

In attendance: F. W. Manker, Chicago sales manager; Frank H. Johnson, Chicago sales representative; L. W. Cross, sales representative; J. S. Curley, sales representative; J. V. Corr, metallurgy; and L. Selmi, metallurgy.

Greenlee Foundry Co., Chicago.—Booth N-12-A.

Exhibiting: "Meehanite" metal castings, which include gears, dies, valves, and other products requiring high test properties. Also, sample specimens and photomicrographs, illustrating properties attainable with "Meehanite Metal."

In attendance: M. A. Scott, sales manager; S. R. Allen, sales representative; and H. W. Johnson, engineer.



Ruggedness

THE Forge Shop today is faced with increasing demands for flawless forgings . . . forgings with the strength and ruggedness to meet the vastly greater speeds and stresses of modern industry.

The quality of the forgings depends, in the final analysis, on the quality of the steel. ASCO Special High Grade Forging Billets are manufactured to meet the most exacting requirements. Extremely tough, dense and free from hidden and surface defects, they cut time and labor costs—produce forgings that are the nearest possible approach to perfection.

Our Metallurgical Laboratories are at your service in developing special steels for special purposes.

ASCO FORGING BILLETS

THE ANDREWS STEEL CO., NEWPORT, KENTUCKY

Carbon, Chrome, Chrome Molybdenum, Chrome Nickel, Chrome Vanadium, Molybdenum, Nickel, Nickel Molybdenum, Vanadium Billets and Slabs.

HOW ABOUT THAT MALUMINUM FLUX?
GREAT STUFF. THE METAL RUNS MORE FREELY AND THE CASTINGS HAVE SHARPER EDGES.
DOES IT REDUCE SCRAP ANY?
YES. THERE'S AN INCREASE PERCENTAGE OF GOOD CASTINGS.

FLUXES
FOR
ALUMINUM
BRONZE
BRASS
LADLE FLUXES FOR
CAST IRON
SPECIAL FLUXES FOR
SPECIAL ALLOYS

THE MALUMINUM COMPANY TRANSPORTATION BUILDING **INDIANAPOLIS, IND.**

Grob Brothers, West Allis, Wis.—Booth N-41.
Exhibiting (in operation): Open end band saw; "Type A-3" (floor model) Continuous Grob filing machine; and "Type B-3 (bench model) Continuous Grob" filing machine.
In attendance: Benjamin Grob and Theodore Grob.

Halcomb Steel Co., Syracuse, N. Y.—Booth K-31.

Handy & Harman, New York.—Booth M-15.
Exhibiting: Brazing alloys and silver solders. "There are three steps we wish to take those who visit our booth through: (1) finished products using our alloys; (2) cut away sections or assemblies showing the various ways in which "Sil-Fos," "Easy-Flo" and "Handy Silver Solders" are used and (3) demonstrations on various types of metal with our alloys in the many different forms we manufacture."
In attendance: George Bechtoldt, A. W. Swift, Leo Edelson and F. T. Van Syckel.

Hardinge Brothers, Elmira, N. Y.—Booth L-31.

Harnischfeger Corp., Milwaukee.—Booth D-42.
Exhibiting (in operation): Demonstration of uniform arc characteristics of new 300-amp. welder; new convertible electric motors; R-Type hoist for handling work in the welding department.
In attendance: F. Wollaeger, sales manager, welder division; Klaus L. Hansen, consulting engineer; C. W. Daniels, general sales manager; and R. Derr, metallurgist.

Hauck Mfg. Co., Brooklyn.—Booth F-37.
Exhibiting: Hauck venturi high and low pressure oil burners, Hauck venturi high and low pressure gas burners, Micro oil regulating valves, duplex oil strainers, venturi suction torches and other portable oil burning equipment.
In attendance: F. John Schwenk, sales manager; R. S. Coulter, combustion engineer; Jules Escheman, Chicago manager; C. Stockman, Chicago district representative; and John J. Connell, St. Louis representative.

C. I. Hayes, Inc., Providence, R. I.—Booth C-34.
Exhibiting: Hayes "Certain Curtain" furnaces; type "HG-52" furnace for heat treating high-speed and high temperature alloy steels; type "LR-61" furnace for heat treating carbon and alloy tool steels, and for preheating high-speed steel; type "HA-4" furnace with water jacketed cooling chamber for brazing and cooling tungsten carbide tipped tools in protective atmospheres. All furnaces equipped with Hayes "Certain Curtain" atmosphere control for protection against scaling, decarburization, and other harmful attack during heat treatment.
In attendance: Carl I. Hayes, president; J. E. Hines, vice-president and sales manager; C. G. Paulson, sales engineer; L. C. Loshbough, Chicago sales engineer; C. A. Hooker, Detroit sales engineer, and E. F. Burke, Cleveland sales engineer.

Haynes-Stellite Co., Kokomo, Ind.—Booth I-1.

Heat Treating & Forging, Pittsburgh.—Booth K-12.

Hevi Duty Electric Co., Milwaukee.—Booth F-11.
Exhibiting (in operation): Miscellaneous electric heat-treating equipment.
In attendance: E. L. Smalley, president; H. E. Koch, vice-president; A. H. Oberndorfer, advertising manager; L. A. Shea, Chicago district representative; J. S. Ayling, Cleveland district representative; L. W. Hayden, Philadelphia district representative; and S. A. Silbermann, Indianapolis representative.

Hobart Brothers Co., Troy, Ohio.—Booth E-7.
Exhibiting (in operation): Five models of Hobart "Simplified" arc welders in sizes ranging from 75 amp. (for welding metal 26 gauge and over) up to 400 amperes (for welding very heavy sections). The display will include many interesting examples of actual welding applications, while an experienced operator will be on hand at all times to demonstrate arc welding on steel, cast iron, copper, aluminum, stainless alloys, manganese steel, and other metals.
In attendance: E. A. Hobart, president and chief engineer; O. H. Menke, engineer; Russell Flora, engineer; W. H. Hobart, vice-president in charge of sales; E. C. Galbreath, general sales manager; W. J. Chaffee, welder distribution; E. K. Butterfield, welder sales; and R. C. Bercaw, practical welding expert.

Hollup Corp., Chicago.—Booth K-3.
Exhibiting (in operation): "Hollup" line of electrodes as well as Westinghouse welding equipment.
In attendance: O. L. Howland, manager of sales; A. M. Candy, R. A. Davidson, R. P. Monroe, Mr. Bender, and W. D. Gannett.

Charles A. Hones, Inc., Baldwin, N. Y.—Booth J-22.
Exhibiting (in operation): Industrial gas burners; immersion tank heater; soldering furnaces; oven furnace; and soft metal furnaces.
In attendance: Charles A. Hones, president; William R. Hones, vice-president; Charles J. Hones, secretary; W. F. De Voe, representative; and B. L. Finn, representative.

Hoskins Mfg. Co., Detroit.—Booth O-11.
Exhibiting: The story of electric heat. We shall display "Chromel" resistor material as "The Wire That Made Electric Heat Possible," and show a practical application of it by featuring one of our small box type electric furnaces equipped with automatic temperature control. There will also be a small display of "Chromel" in the form of small heat-resistant castings.
In attendance: C. F. Busse and Roger F. Waindle, Chicago office; W. D. Little, sales manager; W. A. Gatward, chief engineer; and Charles S. Kinnison, advertising department.

E. F. Houghton & Co., Philadelphia.—Booth D-9.
Exhibiting (in operation): The growing use of "Perliton Liquid Carburizer," a comparatively new process of carburizing in liquid salt baths. An actual carburizing bath, using "Perliton Liquid Heat" and "Perliton Carbon" will be operated and small parts will be carburized to prove the effectiveness of this process. Samples of perlitonized parts of all descriptions ranging from skin hardness to 0.040 in. in depth will be on display. A lighted display of Houghton's line of cutting oils, industrial lubricants, motor oils, steam cylinder oils, spindle oils and extreme pressure oils and greases will be a feature. The company also plans to display a series of automatic slides showing the advantages of Houghton's new straight cut-

HARRY JOHNSON

ANOTHER RECORD *FALLS!*

Object of the admiring gaze of thousands, saluted by the whistles of other craft, the new speed queen of the Atlantic is warped in to her pier after a record crossing. Praise and congratulations are lavishly given to captain and officers.

But few gave due credit to the members of the crew for individual skill and efficiency at their appointed jobs. Few visualized, within the sleek hull, the innumerable mechanisms and devices which made movement and control of the great bulk possible. For records are made through perfection of details.

In small machines and electrical devices there are a few—in giant liners there are hundreds—of vital parts that are more reliable, more durable, more sure to function efficiently when made of **ELEPHANT BRAND** phosphor bronze.

Control the integrity of
your products by specifying
ELEPHANT BRAND
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THE PHOSPHOR BRONZE SMELTING CO.

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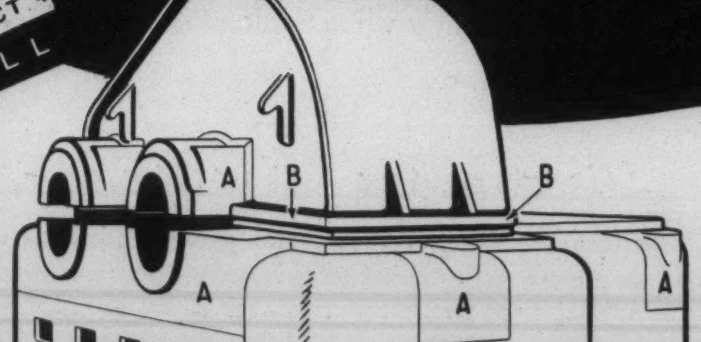
INGOTS • CASTINGS • RODS • WIRE • SHEETS • ROPE • TUBING

The why ★ the how

INTERNATIONAL
METAL EXPOSITION
CHICAGO • SEPT 30-OCT 4
NORTH HALL



Simplifying With Rolled Steel

● Here is a typical instance of the way in which rolled steel permits simplification of product and of production. Rolled steel plus simple castings plus welding save time and save money on big units like this and on small ones, too. Parts labeled A, are castings—B, are cold rolled steel to assure good surface. All other parts are rolled steel.

United States

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ROLLED STEEL CONSTRUCTION

● "How can we apply rolled steel construction to our own products?" This question is asked with increasing frequency by many manufacturers who recognize the economy and the advantages of rolled steel for machine construction.

What types of machinery lend themselves to the more extensive use of rolled steel? What savings are possible? How is weight affected? What production advantages are possible? What types and forms of steel are best suited? What should we know about buying? What are the opportunities for the use of rolled steel combined with castings?

The answers to these and to scores of other questions will determine the policy for a given product. You'll find those answers in a new booklet issued for your guidance.

YOU'LL FIND THE ANSWERS TO YOUR QUESTIONS IN THIS NEW BOOKLET

Send today for this booklet "Rolled Steel For Machine Construction." It was prepared by practical men . . . engineers and designers. It offers a short cut to a more complete understanding of the manifold advantages of rolled steel. And it includes many suggestions on economy in buying and on modern shop technique. A copy is yours for the asking . . . plus further information and the counsel of our representatives if you want it.

ROLLED
STEEL
FOR MACHINE CONSTRUCTION
US

ILLINOIS STEEL COMPANY
208 SOUTH LA SALLE STREET, CHICAGO, ILLINOIS
CARNEGIE STEEL COMPANY
PITTSBURGH, PENNSYLVANIA
Pacific Coast Representatives: COLUMBIA STEEL COMPANY, San Francisco, Calif.

Steel US STEEL Corporation Subsidiaries

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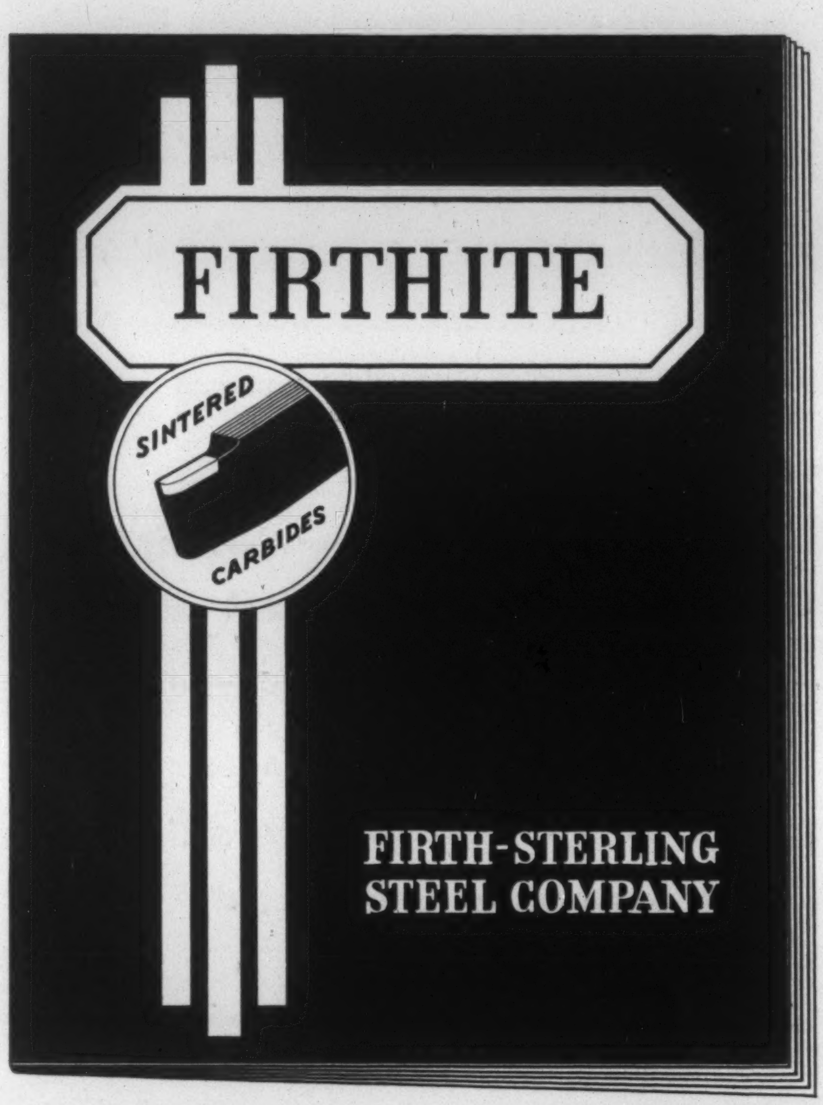
The New Firthite
Sintered Carbide

"BLUE BOOK"



The new Firthite book contains complete detailed information of value to Purchasing Agents, Production Men, and every one interested in the specifying, the ordering, or the performance of Sintered Carbide Cutting Tools. This book is yours for the asking, fill in and mail the coupon for your copy.

FIRTH-STERLING STEEL COMPANY
McKeesport, Penna.

Send me a copy of your new Firthite "Blue Book" on Sintered Carbide Cutting Tools.

Name .... Title ....
Company ....
Street ....
City .... State ....

ting oils which combine the properties of refrigeration and high film strength. As this is the 70th anniversary of the founding of E. F. Houghton & Co., the background display will call attention to the diversified line and the 70th birthday. "Vim Tred Leather Belting" and "Vim Tred" will be included.

In attendance: G. W. Pressel, vice-president and director of sales; G. S. Rogers, general sales manager; C. G. Schultze, sales manager, central division; Harry E. Martin, Detroit sales representative; G. W. Esau, special sales representative, metals division; and D. C. Miner, advertising department.

Illinois Steel Co., Chicago.—Booth E-16.
(United States Steel Corp. Subsidiary).
Exhibiting: See "United States Steel Corporation Subsidiaries."

In attendance: Wm. I. Howland, Jr., G. A. Price, O. H. Baker, H. vanZandt, C. R. Moffatt, H. T. Gilbert, L. B. Worthington, A. P. Selby, J. R. Johnston, C. H. Ten Eyck, V. C. Ward, D. L. Merrell, W. C. Culley, J. B. Hammond, H. F. Hutton, H. E. Morison, J. Brunner, H. R. Glass, G. Fisher, F. S. Crane, F. B. Mulvaney, W. Crabbe, T. Hayes, E. H. Davidson, and C. Reardon.

Illinois Testing Laboratories, Inc., Chicago.—Booth J-11.
Exhibiting: Portable and stationary indicating pyrometers; portable and stationary distant reading resistance type thermometer; thermocouples; and air velocity meters—direct reading.

In attendance: M. D. Pugh, sales manager; J. A. Obermaier, and J. F. Inman.

Ingersoll Steel & Disc Co., Chicago.—Booth L-3.

International Nickel Co., Inc., New York.—Booth E-2.
Exhibiting: Leading industrial applications of nickel and its alloys, such as nickel alloy steels, nickel cast iron, "Ni-resist," "Ni-Hard," Monel metal, nickel bronzes, nickel silver and other copper-nickel alloys. Literature will be available for distribution to interested visitors, and members of our research and development staff will be on hand to discuss problems relating to improvements in equipment by the use of nickel.

In attendance: From sales department: C. McKnight, R. A. Wheeler, E. J. Bothwell, H. S. Lewis, E. A. Turner; from development and research department; T. H. Wickenden, H. J. French, N. B. Pilling, O. W. McMullan, T. J. Wood, J. W. Sands, F. J. Walls, A. L. Roberts, D. M. Curry, E. J. Hergenroether, D. A. Nemser, O. B. J. Fraser, H. L. Geiger, A. G. Zima, and J. S. Vanick.

The Iron Age, New York.—Booth F-23.
Exhibiting: Current copies of The Iron Age.

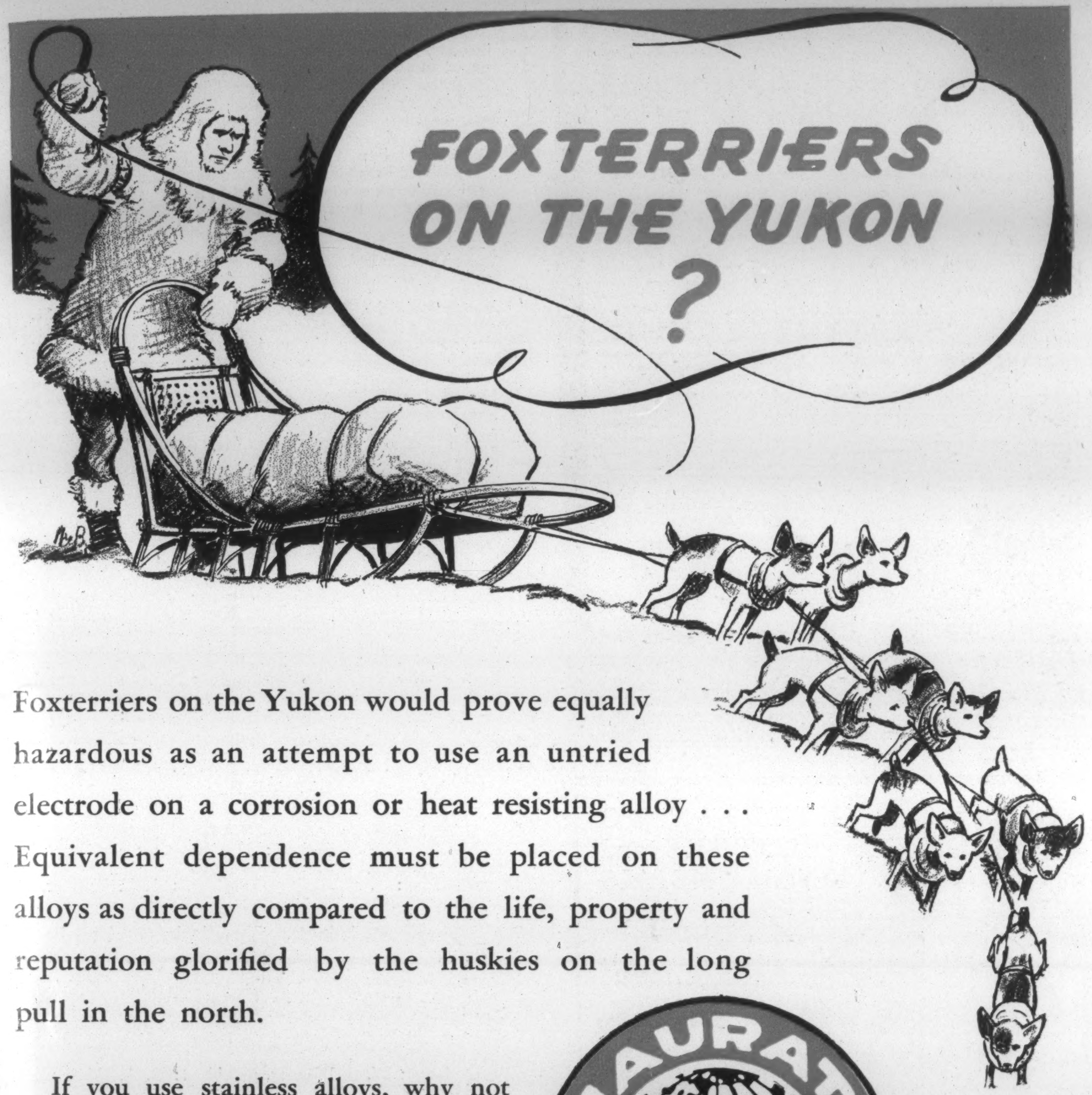
In attendance: F. J. Frank, president; J. H. Van Deventer, editor; C. S. Baur, general advertising manager; H. E. Leonard, assistant advertising manager; O. L. Johnson, research manager; B. H. Hayes, production manager; Emerson Findley, Cleveland representative; B. L. Herman, Buffalo representative; H. K. Hottenstein, Chicago representative; Pierce Lewis, Detroit representative; C. Lundberg, Philadelphia representative; C. H. Ober, New York representative; W. B. Robinson, Pittsburgh representative; W. C. Sweetser, New Jersey representative; D. C. Warren, New England representative; G. L. Lacher, managing editor; T. H. Gerkin, news editor; R. E. Miller, machinery editor; T. W. Lippert, associate editor; M. Waite, associate editor; L. W. Moffett, Washington editor; F. L. Prentiss, Cleveland editor; R. A. Fiske, Chicago editor; G. Ehrnstrom, Jr., Pittsburgh editor; and Burnham Finney, Detroit editor.

C. O. Jelliff Mfg. Corp., Southport, Conn.—Booth M-33.

Jessop Steel Co., Washington, Penn.—Booth N-11-A.
Exhibiting: Five showcases of various sizes framed by moulding made of our "Silverbond Composite" stainless steel strip. One or more articles made up from our steels, chiefly composit steels, and samples of our steels in the rough will be displayed in each of the showcases.

In attendance: T. S. Fitch, assistant superintendent, in charge; Andrew C. Graham, manager, Chicago office; D. J. Hanna, manager, Detroit office; R. E. Malmberg, director of metallurgical department; G. C. Kreuger, sales representative, Chicago and Milwaukee; P. E. Tobin, sales representative, Chicago; L. Williamson, sales representative, Chicago; and J. DeCardy, sales representative, Chicago.

Johns-Manville, New York.—Booth L-12.
Exhibiting: The Johns-Manville line of high tempera-



Foxterriers on the Yukon would prove equally hazardous as an attempt to use an untried electrode on a corrosion or heat resisting alloy . . . Equivalent dependence must be placed on these alloys as directly compared to the life, property and reputation glorified by the huskies on the long pull in the north.

If you use stainless alloys, why not consult the oldest exclusive manufacturer of Alloy Electrodes?

We have the most complete facilities for the production of Alloy Electrodes in the welding rod industry.

MAURATH • IN WORLD WIDE USE • ELECTRODES

MAURATH'S Alloy Data Book and Price List, containing a wealth of useful information, is yours without obligation.

MAURATH, Inc.

7600 Union Ave., Cleveland, O.

"WITH SPENCER AIR SUPPLY"

When you order a furnace or an oven, just add the words, "With Spencer Air Supply." Your manufacturer will select the exact type and size of Turbo required for the best and most economical results and will provide for the location of the Turbo directly on or near the equipment, and ship as a unit ready for immediate operation. . . . . . No more long pipe lines; no more wasting of valuable space, or time. Noise and vibration will not have to be considered, for in Spencer Turbos they have been reduced to a minimum. . . . . Spencer Turbos became a standard for oil and gas-fired equipment because of the simplicity of design, with wide clearances, light-weight impellers and only two bearings; a combination that insures reliable service over long periods. . . . . Recent developments include a line of low-priced single-stage Turbos up to 20 HP., the "Midget" Turbos, ⅓ to ¾ HP., and gas-tight and corrosion resistant turbos in all sizes.

Ask your manufacturer or write us for the new bulletin. . . . . .

SPENCER
HARTFORD
TURBO-COMPRESSORS
MIDGET • SINGLE-STAGE • MULTI-STAGE
35 to 20,000 cu. ft. • ½ to 300 HP. • 8 oz. to 5 lbs.
THE SPENCER TURBINE COMPANY, HARTFORD, CONN.

OF VITAL INTEREST TO CONVENTION VISITORS and ALL WHO FINISH METALS

the JETAL process

A Simple, Economical Process

for coloring iron or steel surfaces at low temperature, by immersion, to a uniform and brilliant black

A complete finish in itself that will not chip, scale, peel or discolor . . . it replaces more involved and expensive black finishes.

An excellent bond for subsequent finishes such as japan, lacquers, varnishes, enamels, etc., that require high temperatures.

Ask for descriptive circular and send samples to be JETALized.

ALROSE CHEMICAL COMPANY
Executive Offices: 80 Clifford Street
PROVIDENCE, RHODE ISLAND

ture industrial insulation with special emphasis on "J-M Superex Blocks" as an insulation behind refractory linings. Also "J-M Refractory Cements" featuring our latest development along this line: "J-M Light Weight Firecrete." Other exhibits will include "J-M Industrial Friction" materials and "J-M Packings."

In attendance: E. H. Younglove, special representative attached to general headquarters staff but located in the Chicago office; W. H. Fogarty, Chicago district manager; G. R. Frankland, assistant Chicago district manager; A. C. Wilson, Chicago district engineer and E. Dowling, assistant Cleveland district manager; also probably some members of the general headquarters staff including: J. A. O'Brien, general sales manager of power products and industrial department and G. E. Grimshaw, sales manager of the high temperature insulation department.

Jones & Laughlin Steel Corp., Pittsburgh.—Booth D-11.

Exhibiting: Principally typical uses of its materials by the metal working industries. The background against which the display will be made is a special set-up that has, as a central panel, a 15-ft. operating model of a blooming mill. The J & L products which will be emphasized are forging steel, Bessemer screw steel, "Jalcase"—both hot rolled and cold finished, spring wire, cold heading wire and tin mill products including "Jalcold" quality. There will also be displays of J & L welded and seamless pipe and construction products used in plant construction and maintenance.

In attendance: Wm. B. Todd, vice-pres.; J. C. Foster, gen. mgr. of sales; R. T. Rowles, mgr., hot rolled sales; J. D. Allen, mgr. cold finished sales; A. W. Herron, Jr., mgr., wire sales; G. C. Congdon, adv. mgr.; A. E. Crockett, mgr. bureau of instruction; H. W. Graham, gen. met.; S. L. Case, supv. of res.; A. A. Wagner, asst. mgr., hot rolled sales; C. C. Henning, asst. gen. met.; W. L. Witney.; C. F. Goldcamp, cold finished sales; J. E. Timberlake, wire sales; John Beck, L. T. Willison and A. M. Reeder, met. engrs. From Chicago: M. A. Blessing, district sales mgr.; R. H. Atwood, mgr., J & L warehouse and sales reps.; B. J. Erwin; I. A. Mlodoch; J. F. Wiedlin; Wm. Petrie; W. Meyer; C. E. Conley; R. Walker; L. C. Rohrer; A. G. Hoover; T. Low, A. F. Price; W. Ross and W. B. Michaelsen. W. J. Bothwell, district sales mgr. and J. W. Robinson, sales rep. from Detroit are also expected to attend.

The J. W. Kelley Co., Cleveland.—Booth K-30.

Exhibiting (in operation): Heat-treating products, industrial oils, and drawing compounds.

In attendance: J. W. Kelley, president; A. F. Ruffner, C. M. Vincent, B. O. Platell, and V. D. Kennedy.

The Kelley-Koett Mfg. Co., Inc., Covington, Ky.—Booth F-5.

Exhibiting (in operation): A miniature working model of an X-ray machine capable of penetrating up to 5½ in. of steel. In addition, many photos and X-ray reproductions will be exhibited which show the many various ways in which "Keleket" apparatus is being used every day in various industries.

In attendance: W. S. Werner, president; D. A. Eddy, vice-president; G. E. Geise, secretary; C. A. Poole, director industrial division; S. W. Hedlund, Chicago representative; H. D. Welch, Chicago representative; C. W. Ransom, Chicago representative; F. W. Geiger, Chicago representative; F. H. Fritts, Indianapolis representative; C. L. Sherratt, Detroit representative; H. A. Shanafelt, Cleveland representative; and H. A. Moore, advertising manager.

The C. M. Kemp Mfg. Co., Baltimore.—Booth J-31.

Exhibiting (in operation): Industrial carburetor for premixing air and gas in predetermined ratio and delivering this mixture under positive pressure to specially designed appliances including gas immersion heating for non-ferrous metals and submerged combustion for heating pickling tanks.

In attendance: E. B. Dunkak, vice-president; Wm. Hunt, development engineer; W. S. Bassett, Mid-West representative; and J. P. Flippen, Pittsburgh representative.

Kloster Steel Corp., Chicago.—Booth A-19.

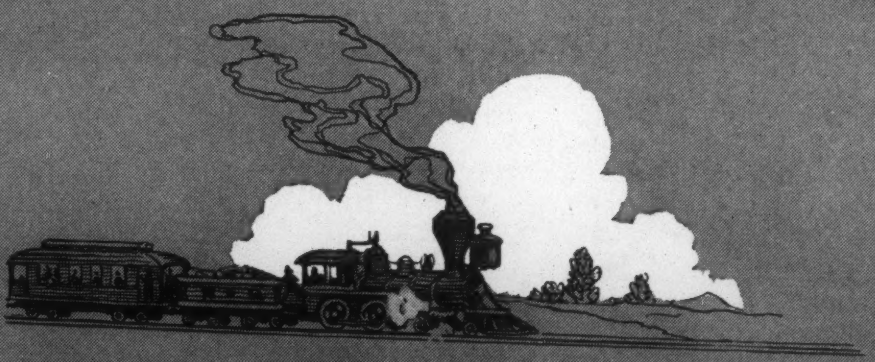
Exhibiting: Complete display of "Pure-Ore" tool steels, special alloy steels, and steel specialties manufactured by Brukskoncermen A. B., Sweden. Also special display of dies and tools.

In attendance: Einar Lindeblad, president and general manager; M. Weisner, special sales representative; O. H. Beall, sales engineer; James B. Cook, metallurgist; C.

1865

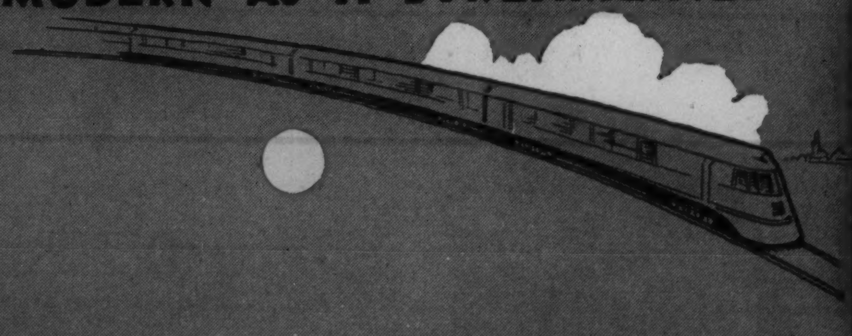
70 YEARS OF SERVICE
HOUGHTON
TO THE INDUSTRIES

1935



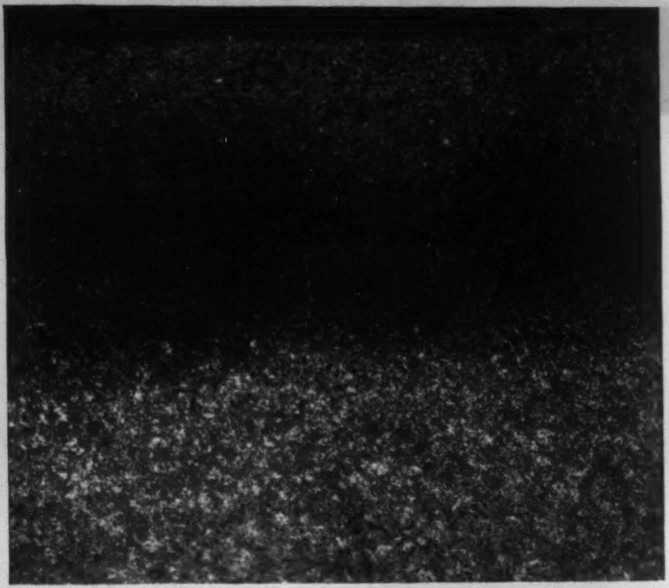
FOUNDED WHEN LOCOMOTIVES WERE WOOD BURNERS

TODAY
•• AS MODERN AS A STREAMLINED TRAIN



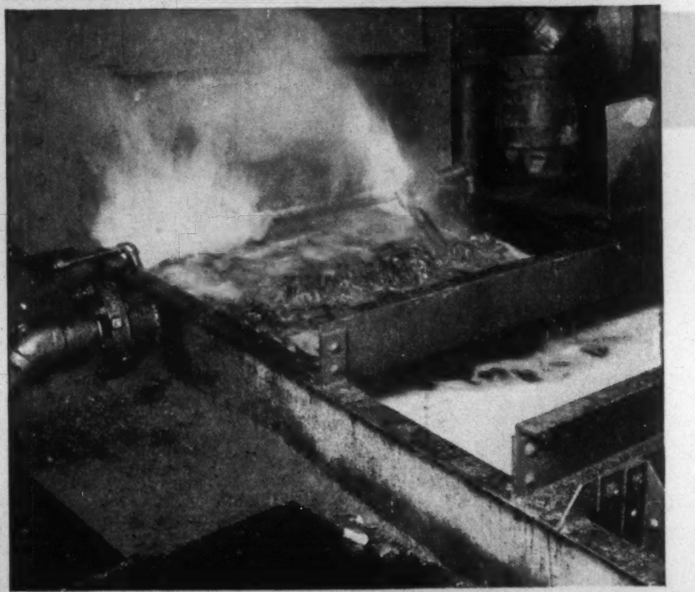
CARBURIZERS
PERLITONIZING
QUENCHING OILS
LIQUID BATHS
CUTTING OILS
RUST PREVENTIVES
METAL CLEANERS
VIM TRED LEATHER BELTING
VIM LEATHER PACKINGS
INDUSTRIAL LUBRICANTS

. . . . presenting the HOUGHTO



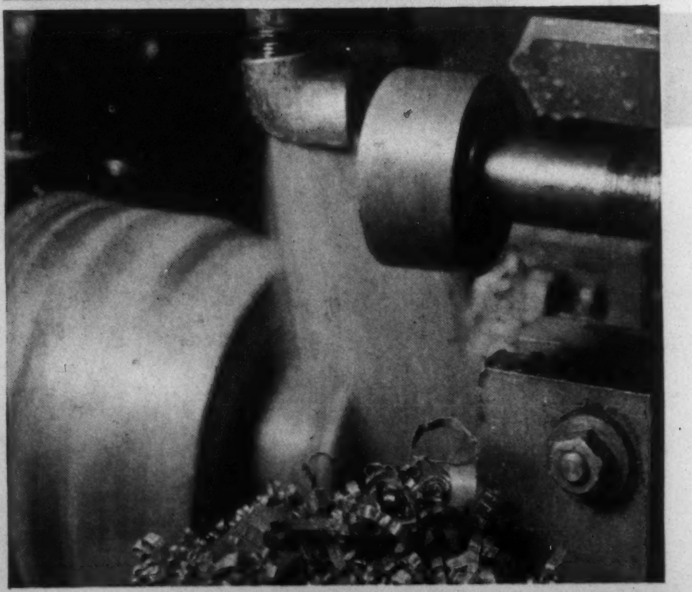
CARBURIZERS

Houghton has been definitely aligned with the science of carburizing since its development of the first uniform patented carburizing material—Hydrocarbonated Bone Black—in 1872. Its energized type of carburizers—PEARLITE and QUICKLIGHT—are used by the millions of pounds for carburizing by pack hardening, with economy, speed and efficiency.



QUENCHING OILS

Houghton's No. 2 SOLUBLE QUENCHING OIL has been the standard for 25 years for hardening steel. It has a decided advantage over all mineral oils in that it cools faster above the transformation range and more slowly in the lower ranges where stresses are set up, thus producing the minimum amount of warping, cracking, etc. It never boils away. . . . assures maximum hardness.



CUTTING OILS

New high-film-strength straight cutting oils and bases that meet modern machining requirements, save regrinds, impart a fine finish to the work. Also a complete line of soluble cutting oils that have stood the test of time in years of efficient service as cutting coolants.

METAL CLEANERS

A variety of types of HOUGHTO-CLEAN—Houghton's effective line of cleaners that have "lifting power," and remove oils, grease, dirt, salts, etc., from metal surfaces with speed and economy. Also grades for general industrial cleaning of walls, floors, etc.

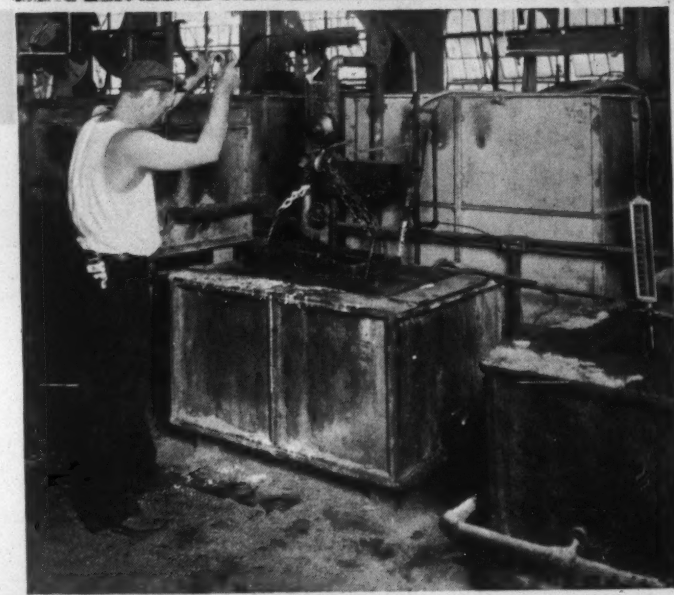
70 years
f service to
INDUSTRY
•
OUGHTON & CO.
CHICAGO
HILADELPHIA
DETROIT

LINE *for the Metal Industries* . . . .

PERLITONIZING

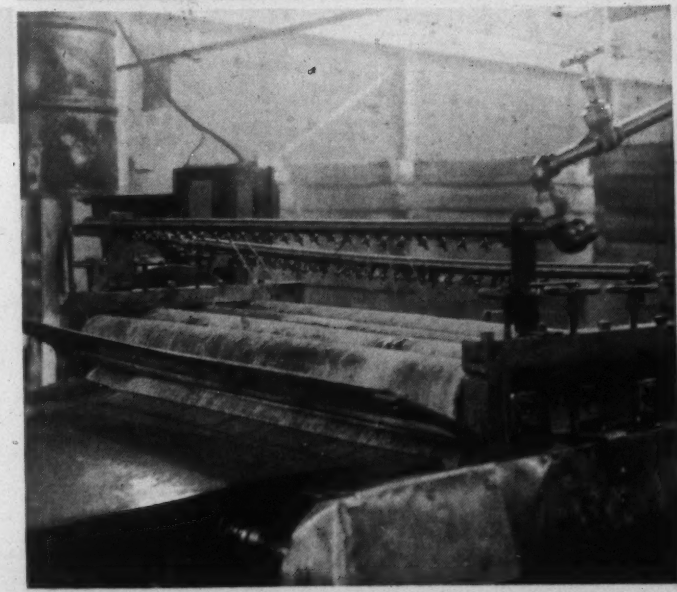
An exclusive Houghton development for carburizing in a liquid salt bath, which provides a true eutectoid case up to .040 inch in thickness, and which is particularly adapted for small parts where speed, uniformity of depth of case and carbon content, and economy are required. Now used by leading heat treaters in this country and abroad.

LIQUID BATHS



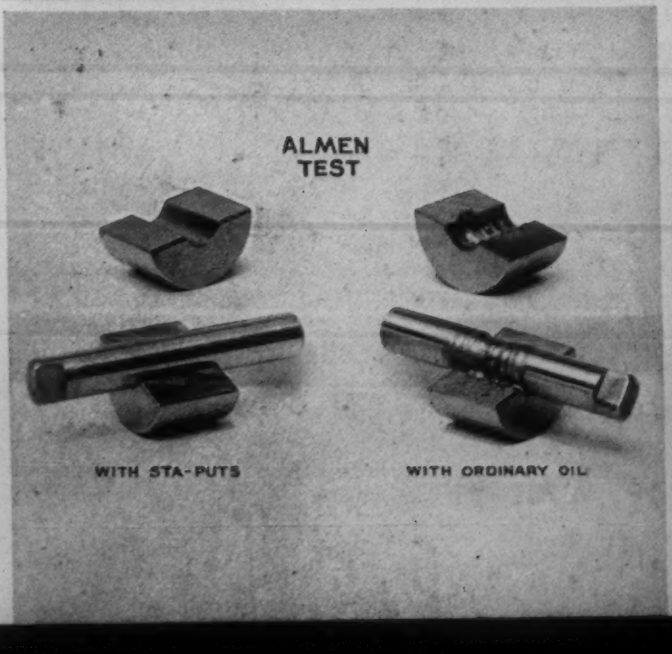
A series of Liquid Heats and Draw Temps for annealing, tempering, drawing, normalizing and hardening, meeting all requirements of the metal industry. Also a superior line of Surface Hardening Powder and Blocks, Cyanides, and every approved method of transferring heat from a hot liquid to a cold solid. Increased production at lower cost is the Houghton slogan.

RUST PREVENTIVES



Rust Veto—used by the U.S. and foreign governments as rust preventives during the war . . . used by famous aviators and polar expeditions to protect planes from salt water and air. Made in a variety of types for every purpose and material from a battleship to a needle.

STA-PUT LUBRICANTS



Here is Houghton's outstanding accomplishment in the field of general industrial lubrication—a complete line of tough-film, leak-resistant lubricants possessing the greatest load-carrying capacity. Made in four general series ranging in service from light to heavy duty machines and gears. Both oil consumption and oiling labor cost are cut as much as one-half in proven cases by using STA-PUTS.

70 years
of service to
INDUSTRY
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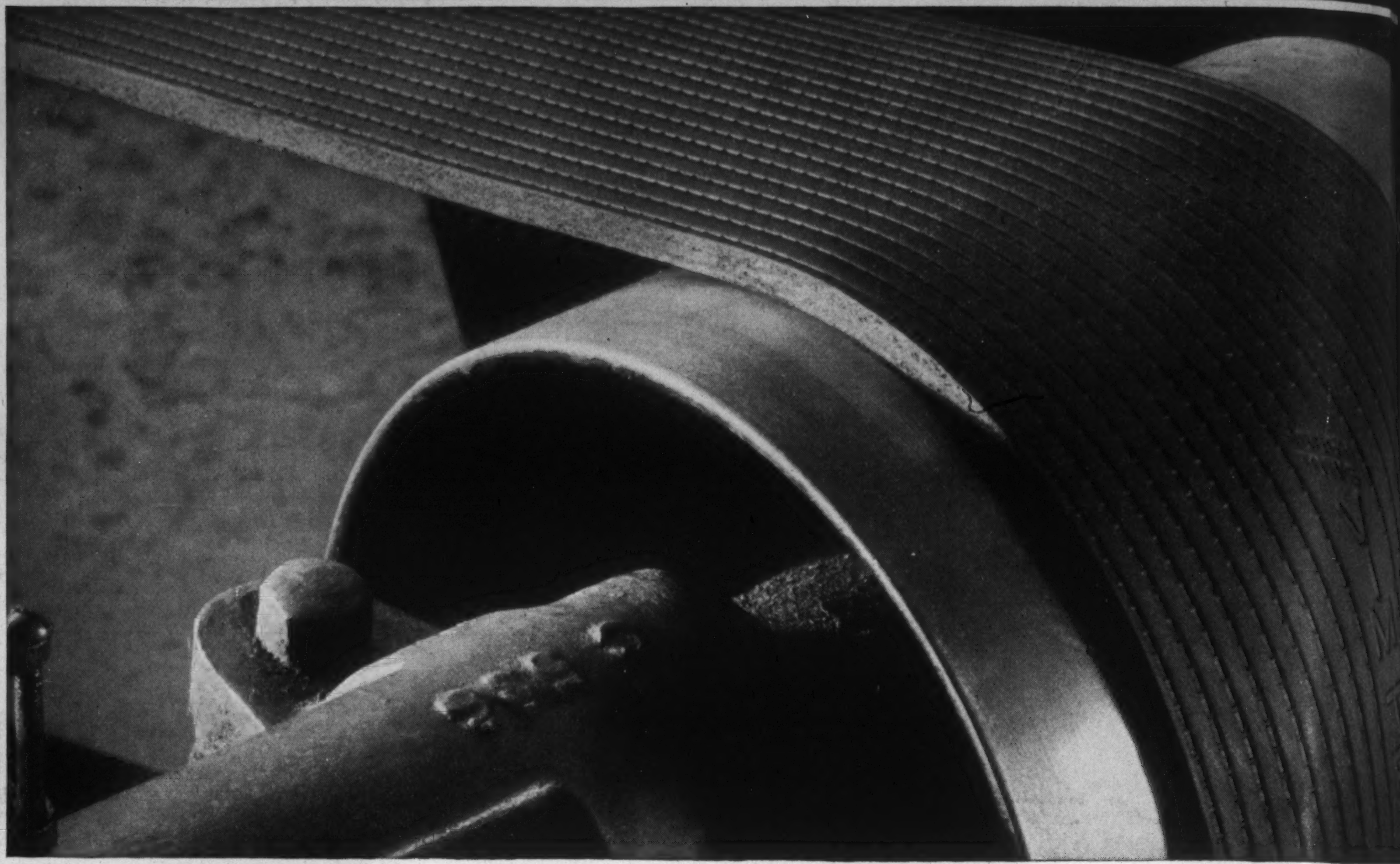
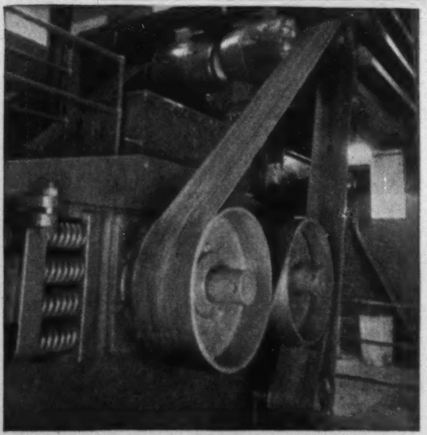
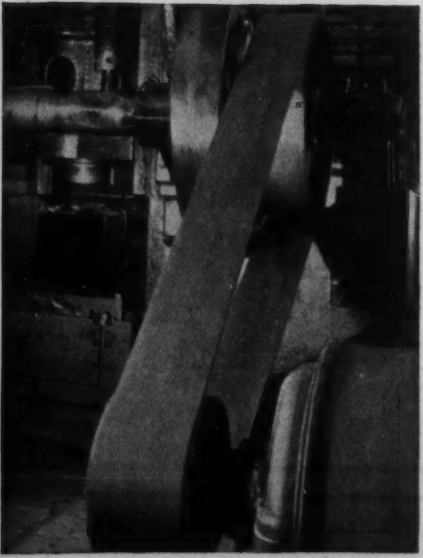
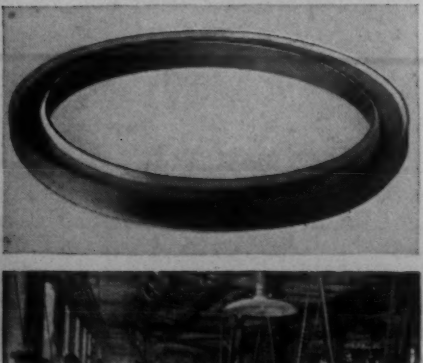
E. F. HOUGHTON &
CHICAGO
PHILADELPHIA
DETROIT

ROUNDING OUT *the* HOUGHTON LIN









OILS
and
LEATHERS
for the
INDUSTRIES
since
1865

VIM TRED
LEATHER BELTING

Made from VIM Leather, live and resilient, highest in tensile strength, tanned from heavier hides by an exclusive process superior for forty years.

Result: A belting leather with longer, tougher fibers, greater flexibility, and the property of great elasticity which minimizes shocks, permitting the belt to stretch under sudden load, then recoil to its original length and take up the load.

Gripping properties have been materially increased by the treaded surface produced by our patented VIM TRED process on the pulley surface of the belt. "Geared-to-thePulley" VIM TRED Leather Belts eliminate vibration and side sway, reduce slippage to a minimum, and provide lower maintenance and longer belting life. The aristocrat of belting!

VIM LEATHER PACKINGS

Made from the long-fibered hides tanned by the superior VIM process, and more generally used for high pressure hydraulic and pneumatic service than any other leather packings on the market.

The reason: VIM Leather Packings are sold with the broad guarantee of *twice* the wear over any other packing. Often they will last from three to thirty times longer.

VIM Leather Packing will not crack . . . is waterproof . . . contains up to 45% more leather fiber than other makes. Try it in your own interests.

(SEE US AT BOOTH D-9 NATIONAL METAL SHOW)

E. F. HOUGHTON & COMPANY
CHICAGO PHILADELPHIA DETROIT

Address Inquiries to 240 W. Somerset Street, Philadelphia, Pa.

A. Peck, metallurgist; and Colin G. Hoyland, president Swedish Steel Mills, A. A.

Leeds & Northrup Co., Philadelphia.—Booth E-42.
Exhibiting (in operation): Three animated sections displaying respectively "Triple-Control Hump Hardening," "Homo Forced-Convection Tempering" and "Micromax Temperature Control." All equipment is in operation.

The section on hardening will contain a triple-control hump "Vapocarb" furnace. An automatically-illuminated cross-section diagram will explain the virtues of each of the three controls.

The section on tempering will show a brick-lined dense-load "Homo" furnace. A temperature exploration test will be conducted on this furnace, the temperatures of six thermocouples throughout the load being recorded by a six-point multi-color "Micromax." An automatically-illuminated cross-section of a "Homo" furnace will illustrate the principle of reversal and show the extreme uniformity of heating secured by means of "Homo" circulation.

The "Micromax" pyrometer section will show the complete line of "Micromax" temperature instruments: strip-chart recording controller, round-chart indicating controller, indicating controller, non-indicating controller, thermotube (radiation) recording controller. A "Micromax" will be available for demonstration purposes and a short continuous movie will show the vital value of automatic standardization.

In attendance: A. E. Tarr, Chicago branch manager, industrial sales division (in charge); G. W. Tall, industrial sales division manager; H. Brewer, market extension division manager; A. F. Moranty, Cleveland branch office manager, industrial sales division; F. D. Burnett; J. W. Harsch, engineering division; T. C. Smith, market extension division, and from the industrial sales division: J. Korp, H. N. MacMichael, T. C. Bennett, W. D. Trueblood, H. F. Coyle, L. H. Coleman, R. L. Wham, and A. A. Degling.

E. Leitz, Inc., New York.—Booth L-24.
Exhibiting (in operation): Latest types of "Leitz Micro-Metallograph, large and small models with darkfield condenser, polarized light and vacuum heating furnace.

A new dilatometer with photographic registration for recording absolute expansion curves and determining critical points. This instrument embodies many new features and is especially suited for accurate determinations of expansions of light metals.

Leitz "Panphot" universal photomicrographic equipment for every conceivable type of photo-micrography and macrography in transmitted or reflected polarized or non-polarized light with direct or indirect illumination.

An entirely new model of the "Guthrie-Leitz" automatic grinding and polishing machine, (in operation).

Accessories and auxiliary devices for metal microscopy and photomicrography. Measuring microscopes for workshop.

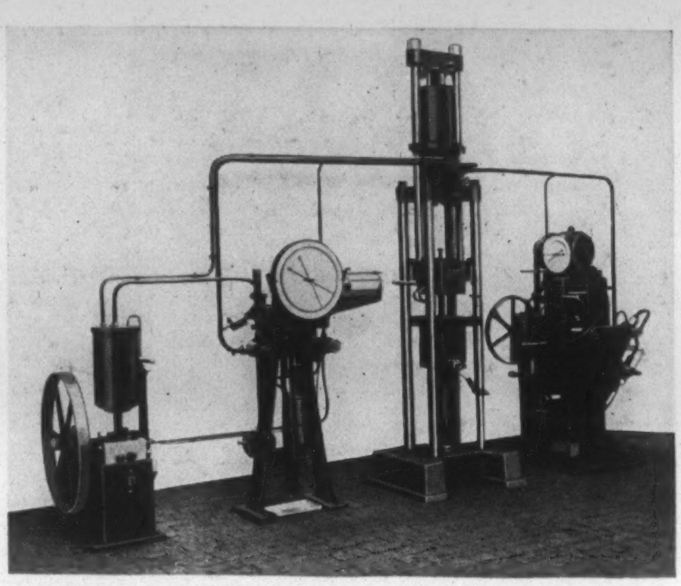
In attendance: H. W. Zieler, technical director; W. H. Kessel, manager Chicago branch office; and F. Schenk, factory superintendent.

The Lincoln Electric Co., Cleveland.—Booth H-3.
Exhibiting (in operation): Latest arc welding machines and new type electrodes. Visitors will see the electric arc in action welding practically all metals including mild steel, high tensile steel, stainless steel, manganese steel, high carbon steel, cast iron, aluminum and copper. Various Lincoln electrodes and the new "Shield-Arc" welder will be used in these demonstrations. The welding of sheet metal will be demonstrated with two new small, motor-generator types of arc welders recently placed on the market by Lincoln. These new machines enable the user to produce in materials as light as 24 gauge the same high quality results as those regularly obtained on the heaviest plate with larger Lincoln machines. Automatic arc welding by the shielded carbon arc process with the "Electronic Tornado" system will be demonstrated daily. The use of two new electrodes "Toolweld" for making cutting edges on machine tools, and "Abrasoweld" for building up straight carbon steel, low alloy or high manganese steel surfaces to resist severe abrasion, will be shown. Also on display will be latest developments in electrode holders, electrode and motor cable, protective shields and goggles, gloves, leggings, wire brushes and automatic welding supplies.

In attendance: A. F. Davis, vice-president; C. M. Taylor, vice-president; V. Peters, welding technician; G. E. Tenney, district sales manager; W. B. Horton, welding en-

AMSLER

Universal Testing Machine



Capacity:
a. in standard, static tests . . 60,000 lbs.
b. in fatigue tests (up to 500 stress-cycles per min.) . . 30,000 lbs.

The time is approaching when it will be *universally* recognized that we must determine the strength properties of metals and alloys not only by applying static loads, but also by exposing them to *rapidly pulsating* stresses, at normal and elevated temperatures.

The time is coming when such repeated-stress tests, using *full-size* bars and complete structural sections, will be performed as part of *routine* test procedure, in accordance with specifications which will be "standard" in all countries.

When that time arrives, it will be realized that of the universal testing machines in general use, *only* the "Amsler" is fully suitable for such test requirements.

Write for Leaflet No. 200

HERMAN A. HOLZ

Complete Line of Amsler Universal Testing Machines, Constructed for Static and Rapidly-Repeated-Stress Applications, or Equipped for Static Tests and Fully Prepared for Later Addition of Pulsating Equipment.

167 East 33rd Street New York, N. Y.

JUTHE

"AMERICAN" Electric and JUTHE Gas Furnaces embrace all the known methods of heat treatment.

They are available in seventy-five standard models and over one hundred special models designed for production treatment of both ferrous and non-ferrous metals.

What they do for others they can do for you. Whatever your heat treatment problems—consult us.

American Electric Furnace Company

29 Von Hillern Street

BOSTON U. S. A. MASSACHUSETTS

gineer; H. B. Downing, welding engineer; W. I. Miskoe, welding engineer; L. G. Hinchman, welding engineer; L. W. O'Day, welding engineer; J. C. Ardagh, welding technician; G. R. Johnson, welding engineer; and C. J. Daniels, welding technician.

Lindberg Steel Treating Co., Chicago.—Booth I-.
Exhibiting: New developments in heat treating.
In attendance: A. N. Lindberg, president; L. A. Lindberg, vice-president and general manager; A. N. Steever, vice-president; R. B. Segar, M. F. Richter, and W. B. MacNerland.

Lindberg Engineering Co., Chicago.—Booth J-8.
Exhibiting: Cyclone tempering furnaces in operation, Lindberg controls in operation, Lindberg shaft quenching machine, Lindberg screw type pot furnace.
In attendance: A. N. Lindberg, F. A. Hansen, C. H. Stevenson, Leon Koenig, and L. H. Remiker.

Linde Air Products Co., New York.—Booth I-1.

Ludlum Steel Co., Watervliet, N. Y.—Booth C-42.
Exhibiting: Display of tool steels, silcrome stainless steels and nitralloy. Exhibit of enlarged copies of Blue Sheets, description of various grades of steels, including analysis and physical properties.
In attendance: P. E. Floyd, district sales manager, Chicago; H. A. DeFries, metallurgist; W. H. Wills, metallurgist; W. L. Weaver, special sales representative; W. J. Fitzgerald, chief inspector; W. G. Zetsche, salesman; E. G. Oeser, salesman; R. E. Surtees, salesman; and Truman Brown, salesman.

The Lufkin Rule Co., Saginaw, Mich.—Booth M-37.
Exhibiting: A complete line of precision tools for the industrial trade such as micrometers (inside and outside, single and in sets), combination squares, calipers and dividers, steel rules, protractors, bevels, gages (telescoping, radius, thickness and screw pitch), and other miscellaneous precision tools. A complete line of measuring tapes, steel, metallic, linen, cotton, mounted on all different styles of frames and reels and in cases. A complete line of rules (steel, aluminum and wood), both folding and straight, with all stypes of graduations. A complete line of flexible rigid steel tape-rules.
In attendance: Theodore P. Young, George W. Stoddart, and Lewis Barnard, representatives.

Lydon Brothers, Jersey City, N. J.—Booth G-22.

Machinery, New York.—Booth A-23.

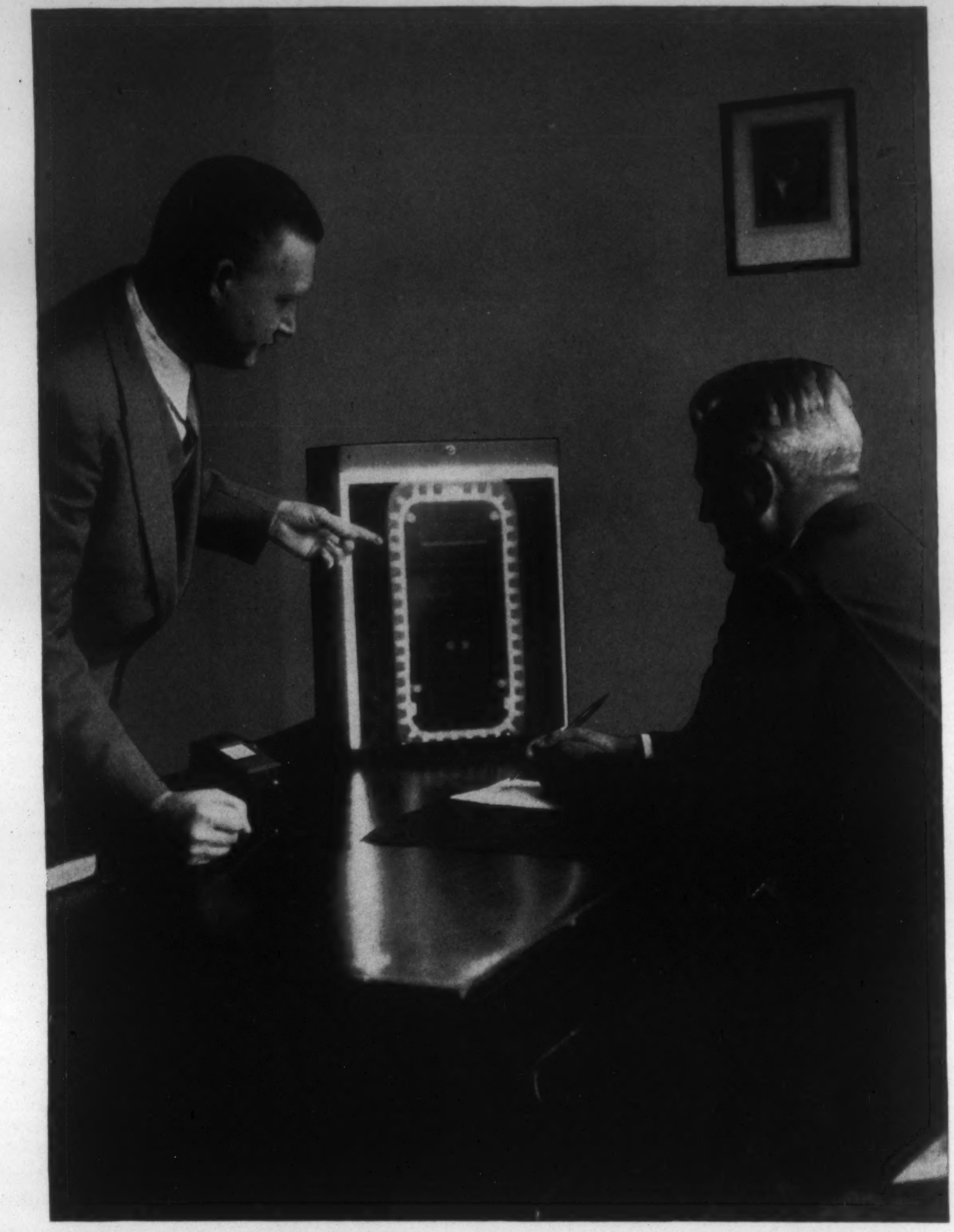
Macklin Co., Jackson, Mich.—Booth E-15.
Exhibiting (in operation): Display board of grinding wheels, large grinding wheels on standard, and cut-off machine (operating).
In attendance: B. F. McIntyre, (vice-president), in charge; J. J. O'Sullivan, H. E. Boschulte, R. Brandt, and L. R. Christiansen.

Magnaflux Corp., Pittsburgh.—Booth F-19.
Exhibiting (in operation): Equipment and specimens for demonstrating "Magnaflux." Inspection of tools, heat-treated parts, tool steel and high speed bars, aircraft engine and automotive parts, springs, etc.
In attendance: A. V. de Forest, president; Chas. A. McCune, secretary; C. E. Betz, engineer of tests; and F. B. Doane, vice-president.

Magnetic Analysis Corp., Long Island City, N. Y.—Booth C-41.
Exhibiting (in operation): One regular portable magnetic analysis equipment and one special portable magnetic analysis equipment for the rapid and non-destructive inspection of steel.
In attendance: Wm. S. Gould, Jr., vice-president; Theodor Zuschlag, engineer in charge of manufacture and development; Frank O. Fischer, engineer in charge of sales and service; and Thomas C. Hana, assistant engineer in charge of manufacture and development.

Mahr Mfg. Co., Minneapolis, Minn.—Booth M-11.

The Manhattan Rubber Mfg. Div., Passaic.—Booth F-7.
Exhibiting (in operation): Manhattan high speed grinding wheels of various types; operating thin wheels, cutting off bars and tubing, tool steels, both hard and soft and various other materials; demonstrating "Campbell No. 203" wet abrasive cut-off machine. Visitors are in-



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"Our manager regards our Keleket Superay equipment as indispensable. It has pointed the way to savings and improvements in welding shop and foundry. It has been the means of getting tough competitive orders for us. We wouldn't be without it."

The company president that wrote this letter expresses the general opinion held of Keleket Superay equipment by operators of modern, successful plants.

Keleket Superay equipment will help you in securing new business by showing "what's inside" your product. It will effect savings by telling the exact condition of your product before it leaves your plant. It will assist in making improvements by letting you "see inside" your product.

You will find Keleket Superay to be one of the most useful and profitable pieces of equipment in your entire plant. Use the coupon below in sending for immediate data.

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THE KELLEY-KOETT MFG. CO.
213 W. Fourth Street,
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Pioneers in the Manufacture of X-ray Equipment Since 1900

THE KELLEY-KOETT MFG. CO., 213 W. Fourth Street, Covington, Ky.
Send me data showing how I can use Keleket Superay equipment to advantage in my plant.
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SMALL ROUNDS

FOR manufacturers of equipment, where the parts require highly polished surfaces and extremely close fit in assembly, B & L engineers offer a special grade of small diameter *ground shafts* — DRAWN, GROUND AND POLISHED to mirror-finish and close tolerances. Available in diameters of $3/4''$ and under.

For details, write for your copy of the new Shafting Folder No. 4-M

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Anneal, Heat Treat or Harden Bright By the Only Method that Does it Right

Use a BELLIS Furnace and *Real* LAVITE

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vited to bring samples of materials they are interested in cutting.

In attendance: W. H. Steinberg, H. D. Gilbert, W. D. Glegg, and F. E. Tiemann.

Charles A. Martin Co., Chicago.—Booth G-20.

Exhibiting (in operation): Martin electric valves operated by standard makes of pyrometer controllers demonstrating: Throttling control, Martin design anticipating control (operates by temperature deviation from control point, and direction of temperature change), special method of control, for automatically equalizing the temperature of two zones within a furnace during heating and soaking

In attendance: C. A. Martin.

Metal Forming Corp., Elkhart, Ind.—Booth N-8-A.

Exhibiting: Rolled hollow mouldings in various metals and alloys, welded, lock and butted joint tubing in plain steel, stainless steel and heat resisting alloys.

In attendance: E. M. Sims, president and general manager; W. A. Amon, sales manager; A. E. Jones, plant manager; K. P. Rush, sales department; and W. S. Yates, Chicago district sales.

Metal & Thermit Corp., New York.—Booth D-30.

Exhibiting (in operation): "Murex" electrodes for arc welding. Its exhibit will contain a demonstration booth and an expert welder will be present so that visitors may watch "Murex" in actual operation or try their hands at welding with these heavy all-mineral coated electrodes. The "Murex" line includes several electrodes developed during the past year for welding the new high strength steels. Among these are "Murex Carbon-Molybdenum-0.50," which is used in the construction and installation of high pressure piping; "Murex Chrome-Copper" designed for welding Cor-ten, Mayari and similar steels; "Murex Cromansil," which is furnished in two grades, one of which deposits a metal with considerably higher tensile strength than the other; and "Murex 4%-6% Chromium" used where high strength and some corrosion resistance are required. Each of these electrodes is designed to deposit a metal closely matching the physical properties of the parent metal on which it is used —for example, "Murex Carbon-Molybdenum-0.50" weld metal has a tensile strength of 70,000 to 73,000 lb. per sq. in., along with 34 percent elongation in 2 in., while the "Murex 4%-6% Chromium" deposit exceeds 100,000 lb. per sq. in. tensile strength and has an elongation of over 20 percent in 2 in.

Also several sample rail welds made by the new Thermit pressure butt-weld process recently developed and now being used for welding rails in main line railroad track.

Metallizing Engineering Co., Inc., New York.—Booth N-1.

Exhibiting (in operation): The Metallizing process, a method of spraying any molten metal so that it will adhere to a roughened solid base without transmitting any appreciable heat to the base material. Display of complete equipment that is required.

In attendance: R. A. Axline, eastern branch manager of Metallizing Company of America; G. S. Lufkin, secretary-treasurer, Metallizing Engineering Co.; W. C. Reid, Chicago branch manager; H. D. Binks, T. Lufkin, and W. Fields.

Metals & Alloys, New York.—Booth M-32.

Exhibiting: METALS & ALLOYS, "The Magazine of Metallurgical Engineering." Also, metallurgical books.

In attendance: Dr. H. W. Gillett, editorial director; Edwin F. Cone, editor; Richard Rimbach, consulting editor; P. H. Hubbard, publishing director; Wm. P. Winsor, advertising manager; G. E. Cochran, Chicago district manager; and R. M. Creaghead, Cleveland district manager.

Lee B. Mettler Co., Los Angeles.—Booth G-28.

Michiana Products Corp., Michigan City, Ind.—Booth H-8.

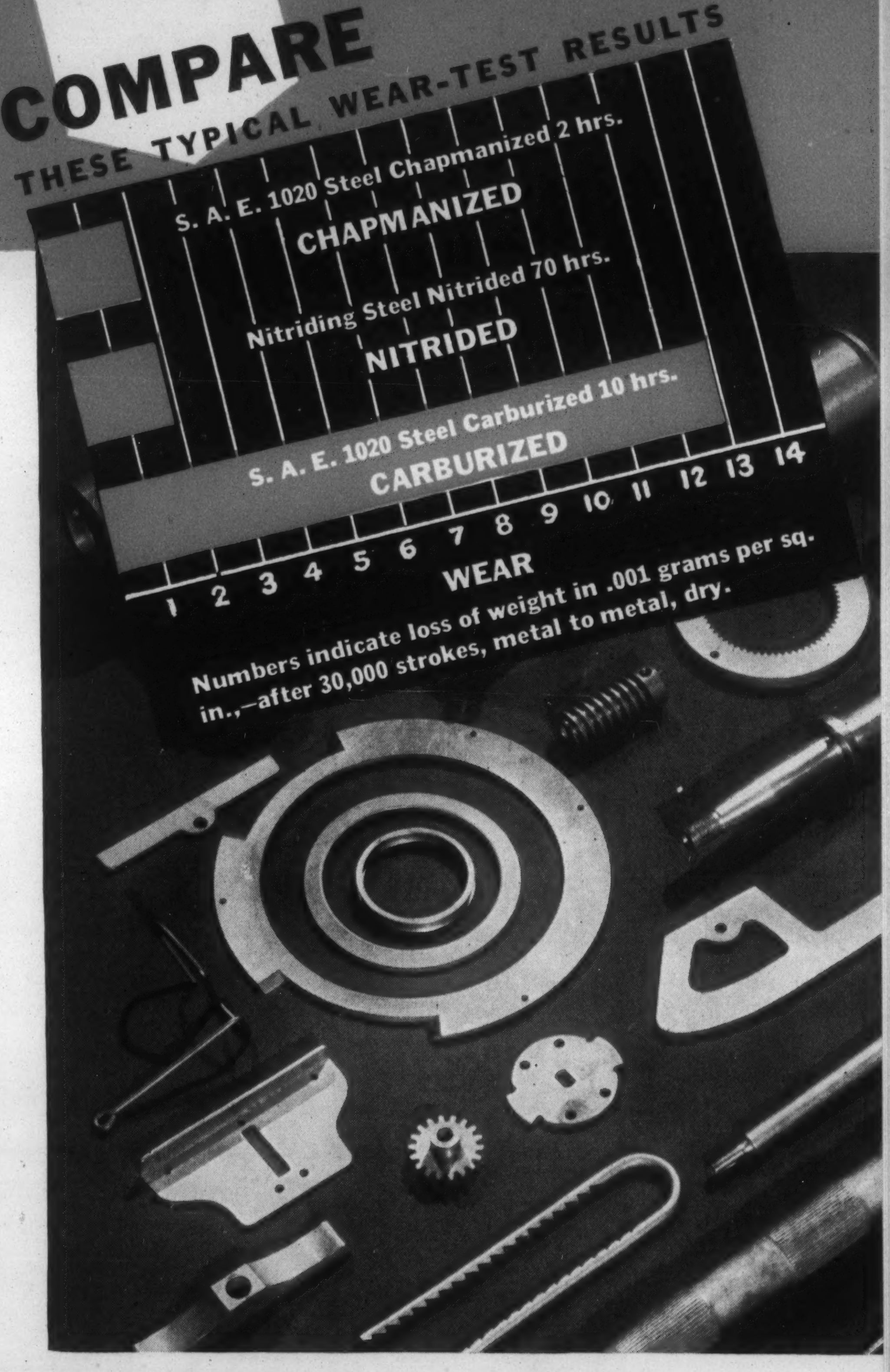
Exhibiting: Heat and corrosion resistant alloy castings, and oil filters.

In attendance: O. M. Carry, president; Henning Klouman, manager alloy division; R. N. Burckhalter, manager sheet steel division; L. H. Whiteside, manager of sales alloy division; W. B. Cooley, Indianapolis; A. A. Cash, Detroit; E. E. Whiteside, Cleveland; P. S. Menough, Pittsburgh; and C. M. Conner, Philadelphia.

Michigan Tool Co., Detroit.—Booth I-3.

CHAPMANIZING

FOR HARDER SURFACES... FOR LOWER COSTS



Instead of costly alloy steels, many manufacturers are using inexpensive, low-carbon steels—*Chapmanized.* They are making substantial savings—not only in steel costs, but in machining and hardening time.

And—equally important—their products last longer. For Chapmanizing produces a surface hardness in 3 hours that will outwear about nine to one the hardened surface made by ten hours of carburizing—*a surface equal or superior in hardness to that of nitrided alloy steel.*

Chapmanizing imparts a hardness of between 700 and 1100 Brinnell as required, with any desired depth of case from .002" to .035". Moreover, with all its hardness, Chapmanized steel retains a tough, ductile core, and the surface will not chip, flake or crack.

Yet—Chapmanizing actually costs less than other case-hardening methods. You can Chapmanize your parts by putting a Chapmanizing unit in your plant on a contract basis—requiring not one cent of investment or the purchase of any auxiliary equipment. Or you can ship your parts to Indian Orchard and we will Chapmanize them and ship them back within 24 hours.

If you are interested in lowering costs and giving added wear to your products, you'll want to see the Chapmanizing exhibit at the National Metal Show—or send for our new book on Chapmanizing. Use the coupon below. Mail today.

AT THE NATIONAL METAL SHOW
—we'll be looking for you at
BOOTH A-32

The CHAPMAN VALVE MANUFACTURING COMPANY

Indian Orchard, Massachusetts

SEND FOR THIS BOOK

—it tells exactly what Chapmanizing is—what it does—how it compares with other case-hardening methods in *results*—how you can use Chapmanizing to turn out longer-wearing parts at less cost. Mail the coupon.

CHAPMANIZING
. . . A NEW PROCESS FOR HARDENING LOW CARBON STEEL

THE CHAPMAN VALVE MANUFACTURING CO.
Indian Orchard, Mass.

Gentlemen: Please send me a copy of your new book on Chapmanizing.

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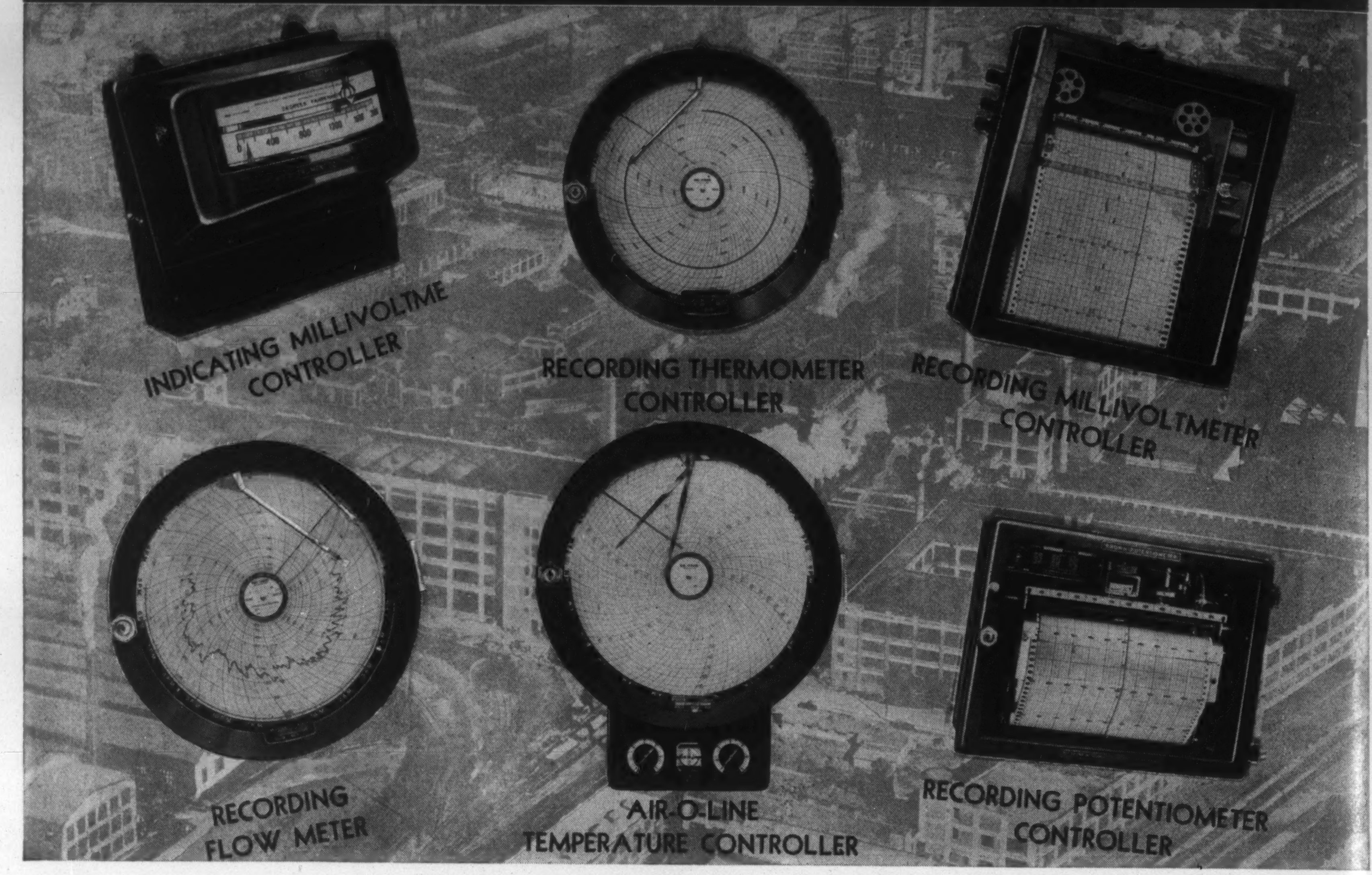
INDICATING MILLIVOLTME
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ARE ACHIEVED ONLY AS RELATED EQUIP-

ASK TO SEE THE
NEW BROWN
Air-o-Line

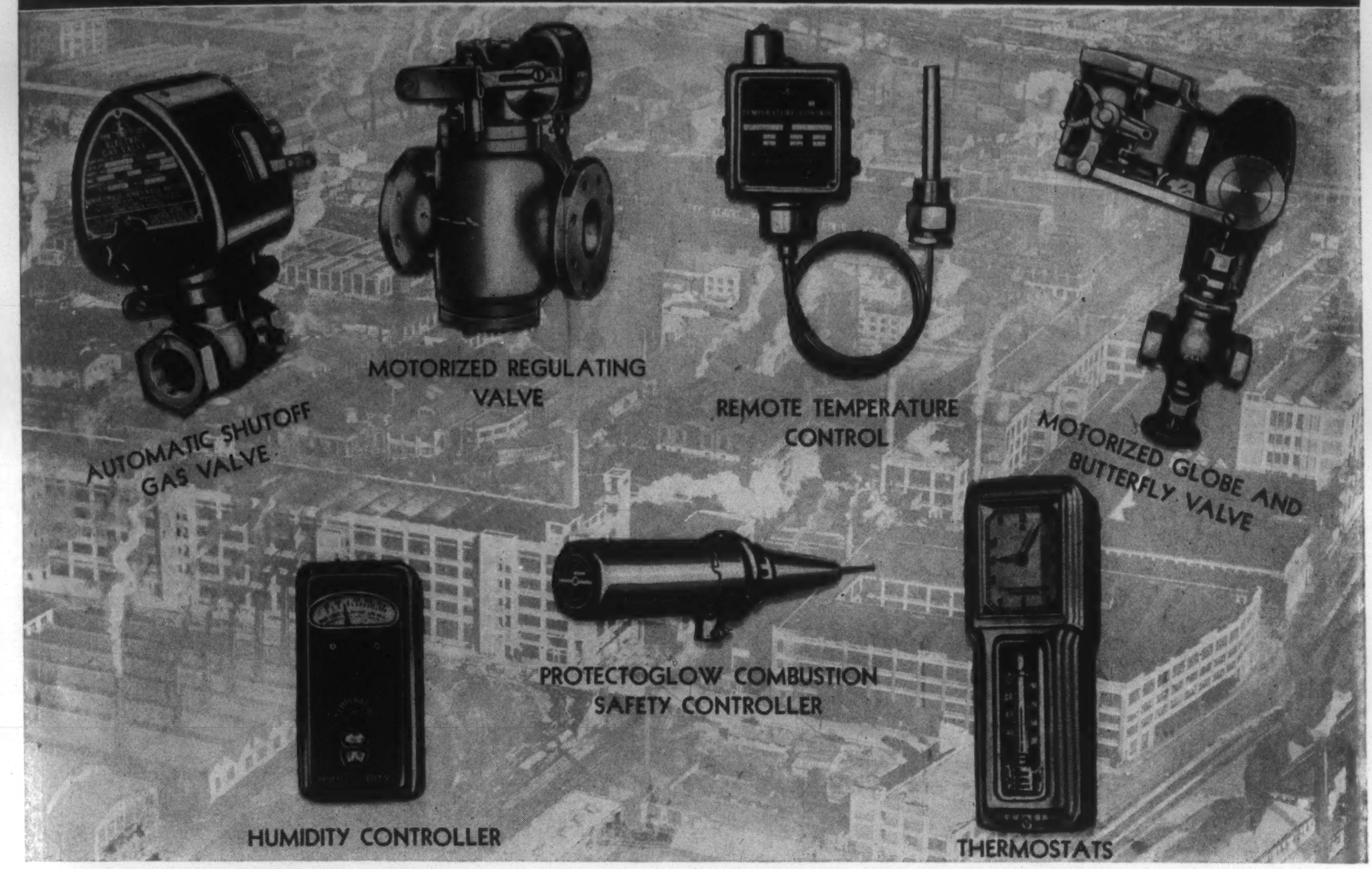
REGARDLESS of the size or complexity of your heat treatment and control problems, Brown Instruments and Minneapolis-Honeywell controls provide a dependable and unified system wherein each unit is accurately coordinated with operating conditions—assuring increased efficiency and economical operation.

The Consolidation of the Brown Instrument Company and the Minneapolis-Honeywell Regulator Company makes available to the metal working industry 125 years of experience in pioneering, perfecting and applying measuring and automatic control equipment that simplify processes, eliminate retreatments, increase uniformity—factors which produce substantial savings in production costs.

BROWN INSTRUMENTS and

To Measure and

MEASUREMENT and CONTROL
National Metal Exposition


AUTOMATIC SHUTOFF GAS VALVE
MOTORIZED REGULATING VALVE
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MOTORIZED GLOBE AND BUTTERFLY VALVE
HUMIDITY CONTROLLER
PROTECTOGLOW COMBUSTION SAFETY CONTROLLER
THERMOSTATS

IN HEAT TREATING
MENT IS SCIENTIFICALLY COORDINATED

Whatever need you have for recording, indicating and controlling temperatures, pressure, flows and other factors, you will find among the Brown and Minneapolis-Honeywell line the correct instruments for your exact purpose. These instruments, some of which are shown above, will be exhibited at our Booths J 15 to J 19.

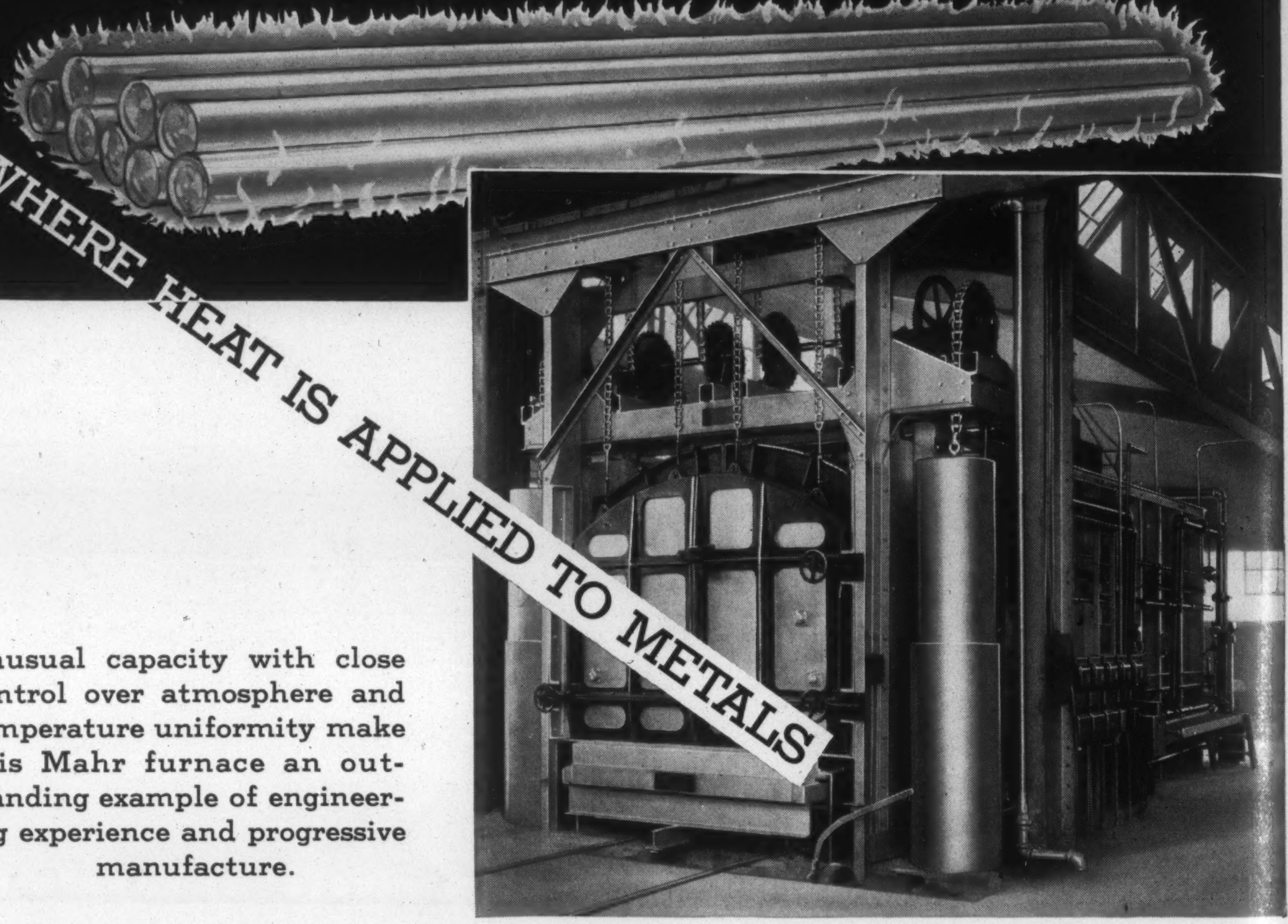
The men in attendance will be able engineers who know your work and will be glad to cooperate with you in working out your measurement and control problems. There is no obligation. For catalogs and information write the Brown Instrument Company, 4517 Wayne Avenue, Philadelphia, Pa.—Minneapolis-Honeywell Regulator Company, 2753 Fourth Avenue, South, Minneapolis, Minnesota. Offices in all principal cities.

MINNEAPOLIS-HONEYWELL Control Systems

Control is to Economize

MAHR

in step with progress



Unusual capacity with close control over atmosphere and temperature uniformity make this Mahr furnace an outstanding example of engineering experience and progressive manufacture.

Modern furnace designs—continuous or batch type—must provide extremely close control over temperature, atmosphere, and mechanical operation. Correct designs will reduce manufacturing costs and insure a quality of production that cannot be accomplished with the ordinary furnace.

Mahr engineers solicit the opportunity to offer such correct designs whether your requirement is for a small batch type—a continuous furnace—or a large, zone controlled unit.

GAS • ELECTRIC • OIL

MAHR MFG. CO.

MINNEAPOLIS, MINNESOTA, U. S. A.

A. Milne & Co., New York.—Booth L-41.
Exhibiting: Milne tool and die steels; hollow drill steel; solid drill steel; auger drill steel; special sections; MR Swedish Lancashire iron; all steel anvils; forged tools; Wardlow's file steel; and Wardlow's cutlery sheets.
In attendance: H. S. Hoyt, member of firm; J. King Hoyt, Jr., member of firm; V. A. Greene, sales manager; H. R. Adams, Chicago branch manager; E. R. Carnell, C. C. Pinkney, R. P. Rice, J. I. Kitts, and E. Q. Sylvester, salesmen.

Minneapolis-Honeywell Regulator Co., Minneapolis.—Booth J-15. See Brown Instrument Co.

Molybdenum Corp. of America, Pittsburgh.—Booth F-25.
Exhibiting: Mural of steel plant lighting effects, etc. Sample of various products manufactured by company.
In attendance: Earl Steward, western district manager; N. F. Tisdale, metallurgical engineer; V. R. Lansing, vice-president; W. H. Phillips, vice-president; and H. P. Furlong, Detroit district manager.

Monarch Engineering & Mfg. Co., Baltimore.—Booth I-21.

National Cylinder Gas Co., Chicago.—Booth L-15.
Exhibiting: Oxygen, acetylene, hydrogen, carbide, gas welding rods and welding electrodes, and "Corta" cutting machine. This is a new design universal cutting machine capable of cutting straight lines, circles, and irregular shapes of any kind. It is suitable for the manufacture of single jobs or repetition work. It is possible to cut any shape without special devices. This machine will be in operation.
In attendance: W. J. Lacey, district manager; H. C. Dowson, J. L. Adank, C. W. Steel, and C. D. McGuinn, of the sales department, and H. E. Winkelman, service operator; Henry Booth, sales manager of Midwest Carbide Corp.

National Industrial Publishing Co., Pittsburgh.—Booth F-19-A.
Exhibiting: "Industrial Heating"—a monthly publication, devoted to all industrial heating processes, furnaces, ovens, kilns, etc.
In attendance: I. S. Wishoski, editor.

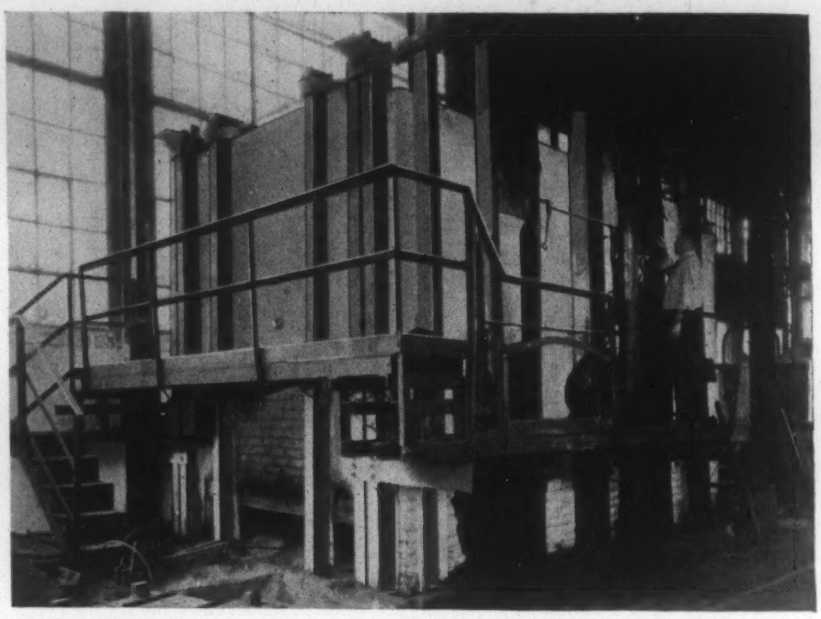
National Tube Co., Pittsburgh.—Booth E-16.
(United States Steel Corp. Subsidiary)
Exhibiting: See "United States Steel Corporation Subsidiaries."
In attendance: H. E. Passmore, E. C. Wright, W. L. Schaeffer, J. S. Raymond, H. W. Mollison, and B. H. Rickard.

The **New Jersey Zinc Co., New York.—Booth C-20.**
Exhibiting: Zinc alloy die castings. The display will consist of new and unusual applications of zinc alloy die castings taken from many varied fields. Many die castings will be shown in as-cast form as well as in various types of plated and lacquered or enamelled finishes. There will also be a great many complete assemblies of electrical appliances, business machines, small tools, household equipment, etc., in which the zinc alloy die castings will be shown in actual application.
In attendance: A. E. Mervine, manager, metal division; W. P. Hardenbergh, Jr., assistant manager, metal division; D. P. Brannin, manager, Chicago metal sales; R. F. Burns, Chicago metal sales; W. W. Broughton, technical service division; S. E. Maxon, technical service division; C. R. Maxon, market development division; R. L. Davis, market development division; R. Davison, manager, market development division.

The North American Mfg. Co., Cleveland.—Booth M-34.
Exhibiting: Adjustable orifice control valves for both oil, air, and gas; proportioning valves for oil and air, and proportioning valves for gas and air; also nozzles and mountings and a general line of gas and oil burning equipment.
In attendance: George C. Davis, Chicago sales engineer; S. E. Shepard, Detroit sales engineer; O. C. Bernhard, Pittsburgh sales engineer; and C. E. Sladky, Cleveland sales engineer.

Norton Co., Worcester, Mass.—Booth A-41.
Exhibiting: Grinding wheels and other abrasive products.
In attendance: W. N. Jove, Chicago; A. S. Rakestraw, Chicago; R. E. Taylor, Chicago; H. E. Walston, Chicago; H. K. Clark, general sales manager, Worcester; W. R. Moore, sales manager, abrasive division, Worcester; and

ANNEALING FURNACE
INSULATED
with
SONITTEP INSULATION CEMENT
(S. I. C.)



"Controlled Atmosphere in Steel Treating" presents many problems.

Among these are air-infiltration and accurate temperature control.

S.I.C. stops air-infiltration.

S.I.C. makes accurate temperature control more possible.

S.I.C. saves 5% to 25% of fuel consumption.

S.I.C. increases refractory life.

S.I.C. has many advantages over other forms of insulation.

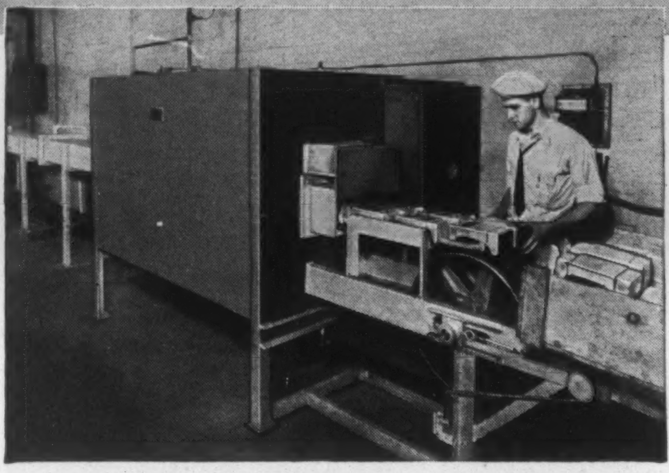
Insist on S.I.C. for your insulation problems.

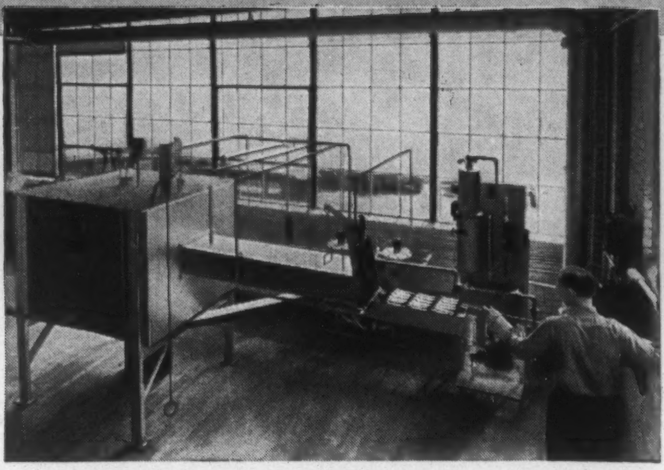
Write for Information

GEORGE F. PETTINOS, INC.
Philadelphia, Pa.

[a cement for every purpose]

GREATER PROFITS
G-E ELECTRIC





Crowe Name Plate & Mfg. Co.
reduces rejects and pickling costs with this G-E CONTROLLED-ATMOSPHERE ELECTRIC FURNACE

This G-E continuous-bright-annealing furnace is making three important savings for the Crowe Name Plate & Mfg. Co., Chicago, in annealing nameplates, radio dials, emblems, etc., between stamping operations. Since the parts annealed come out bright and clean, pickling costs are entirely eliminated. Because of the excellent temperature distribution in the furnace, all parts are annealed more uniformly, reducing the number of rejects and the wear and tear on the dies. Moreover, the dies now make clearer-cut impressions.

You may not make punchings and stampings, but if you anneal your product, a G-E controlled-atmosphere bright-annealing furnace will save you money through trouble-free service and long furnace life.

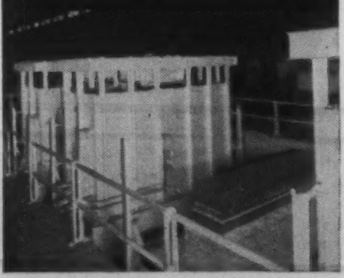
How Remington Rand
SAVES MONEY with G-E ELECTRIC-FURNACE BRAZING

The Dalton Powers Division of Remington Rand, Inc., located at Norwood, Ohio—makers of accounting and adding machines—is now making substantial savings in production and service costs by G-E electric-furnace-brazing more than 150 machine parts. Riveting, pinning, and torch brazing proved unsatisfactory and costly for many of the small parts which are subjected to repeated vibration and severe impacts during everyday service. G-E electric-furnace brazing has improved the strength, quality, and life of these parts by giving them strong, ductile, vibration-resisting joints. This has reduced rejects and service costs to the minimum.

If you are now riveting, pinning, soldering, or torch-brazing small parts subjected to severe stresses, G-E electric-furnace brazing will save you money.

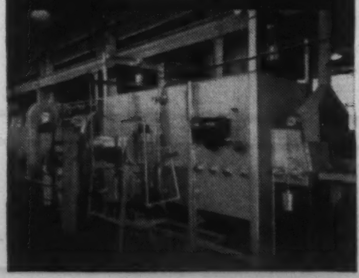
YOUR EVERY NEED IN ELECTRIC

RECTANGULAR BELL-TYPE FURNACES



For annealing steel sheets

ROLLER-HEARTH FURNACES

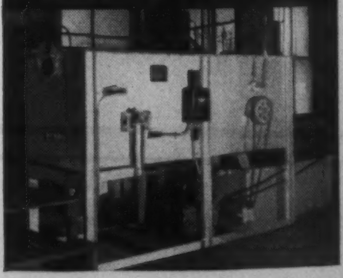


For annealing sheets, strip, bars, and tubes

PUSHER-TRAY FURNACES

For annealing stampings, punchings, coiled strip, and wire

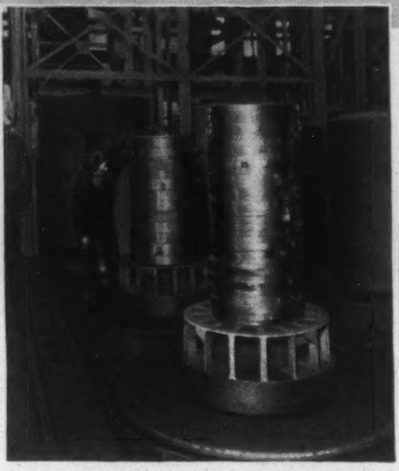
CONTINUOUS HEAT-TREATING FURNACES



For heat-treating small machine parts

GENERAL

FOR USERS OF FURNACES



They wanted high quality — today's best sales appeal
They got it with G-E BELL-TYPE ELECTRIC FURNACES

The steel companies in whose mills these pictures were taken, now bright-anneal their coiled steel strip in G-E controlled-atmosphere, bell-type electric furnaces because these furnaces assure them of a more uniformly bright-annealed product—a higher-quality product that increases sales possibilities. In addition to high quality, these companies obtain three other important advantages. These furnaces permit quicker shipments and a greater daily output at lower cost because of their shorter annealing cycle. Rejects are fewer, since every coil in the stack is bright-annealed uniformly as a result of the even temperature distribution in the furnaces. The low temperature differential between the heating elements and the charge means long resistor life and lower maintenance costs.

For complete information on G-E electric furnaces, write to General Electric, Dept. 6-201, Schenectady, N.Y.

ANNOUNCING . . . **AN OPPORTUNITY TO SEE G-E ELECTRIC-FURNACE BRAZING — HOW IT IS DONE — HOW IT CAN SAVE YOU MONEY.** At our exhibit in space A-3 at the National Metal Exposition, there will be a complete G-E controlled-atmosphere electric furnace, performing copper-brazing operations on a production basis. When you see this furnace in operation, contrast its simplicity and economy with other fabricating methods.

FURNACES FROM ONE MANUFACTURER

BOX-TYPE FURNACES

For run-of-the-mill heat-treating jobs

AIR-DRAW FURNACES

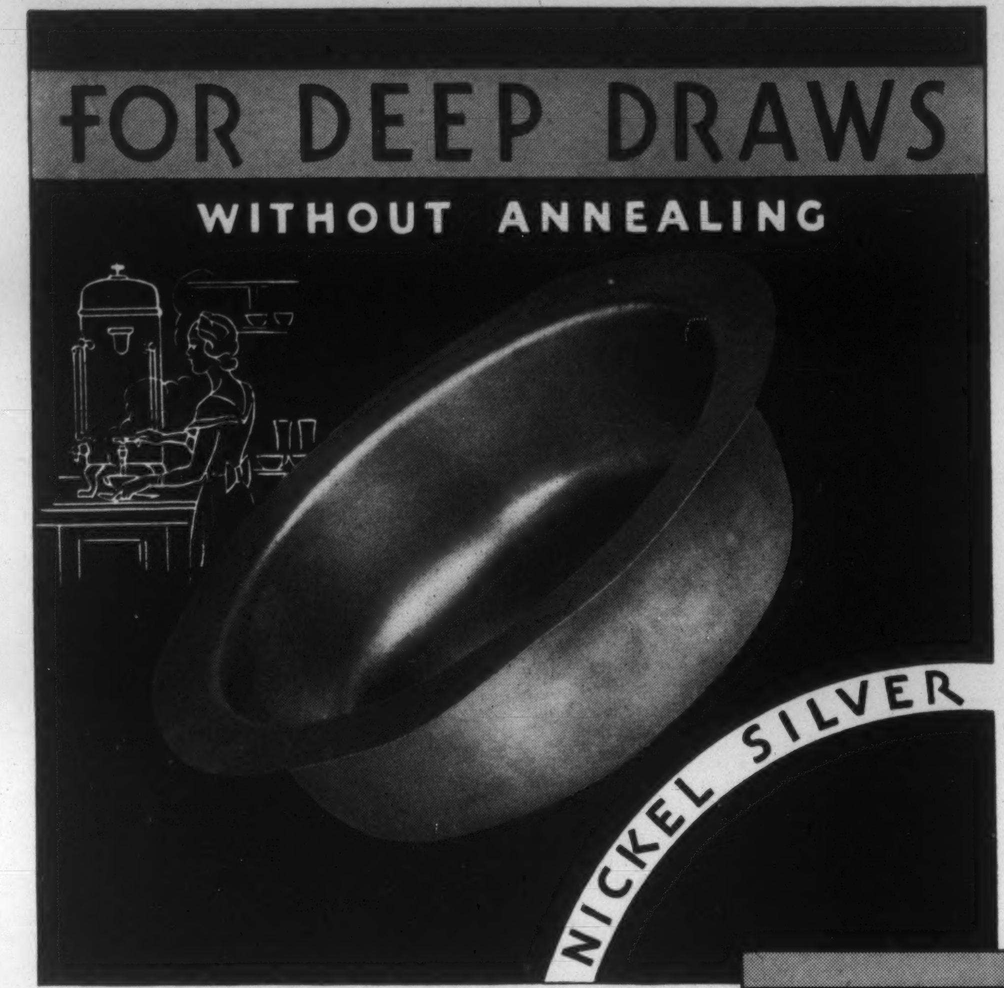
For drawing miscellaneous steel parts

CONTINUOUS ENAMELING FURNACES

For high-quality, low-cost enameling work

170-29

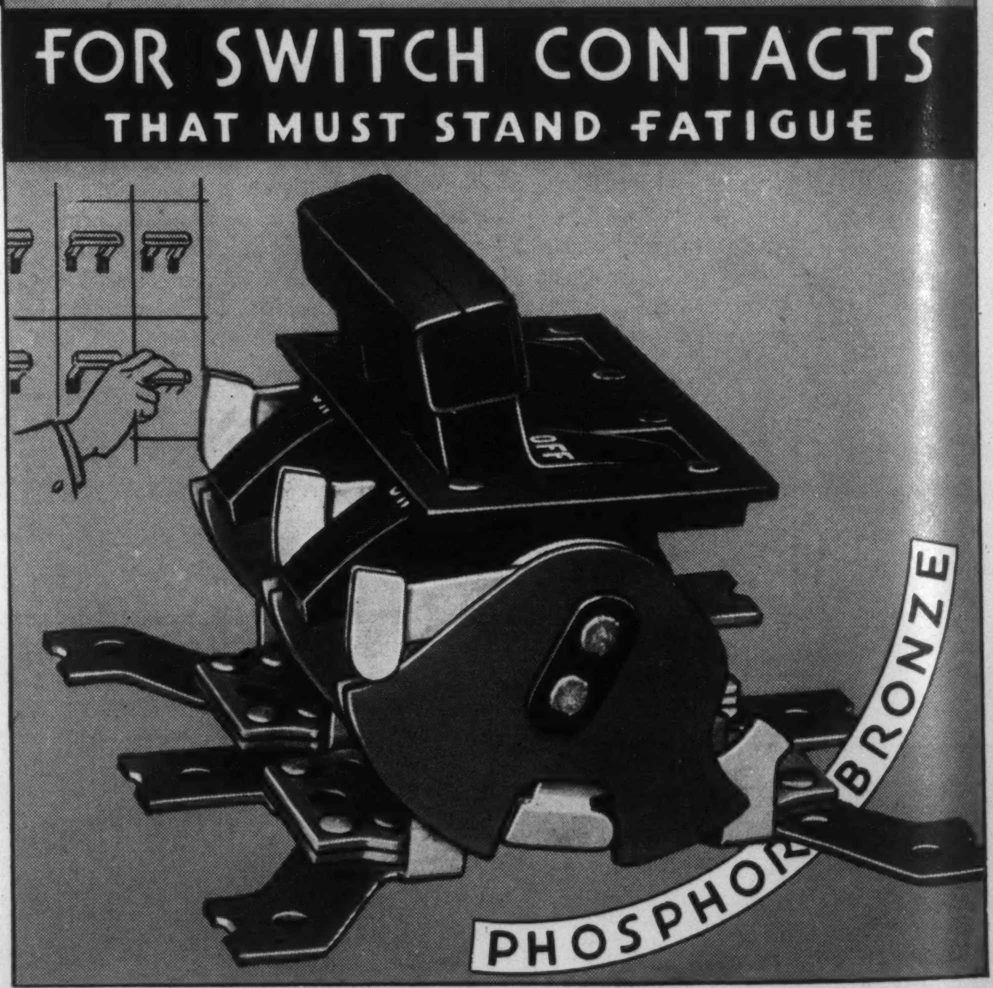
ELECTRIC



The shell at the left, a coffee urn lid in the making, was drawn to a depth of 5¼″ in a single draw, from a 20-gauge Seymour 18% soft Nickel Silver circle 21″ in diameter. No giant press was used; the work was done on a No. 2½ Bliss Draw Press.

Absence of annealing, a process which softens a shell all over, is an advantage, as it preserves strength where strength is needed—at the top in this case.

Seymour Nickel Silver is a highly ductile alloy. In drawing or spinning, it flows smoothly without strain. Coming out free from splits and open pores, it usually avoids the grinding operation. Also an advantage, where the article is to be silver plated, is the silvery white color of Seymour Nickel Silver, which, when exposed by wear, matches the surrounding plate.



The rotating assemblies in the 250-volt, 60-ampere heavy duty switch at the right are made of Seymour Phosphor Bronze because of its strong spring tension and good conductivity.

At each "ON" throw of the switch, these assemblies, composed of two plates, are driven into contact with terrific force by heavy coiled springs, the impact separating the plates to effect the grip on the contact plate. This grip must be sustained for many years; and, to make sure of it, the assemblies are put through a "fatigue" of 50,000 impacts! Evidence of the ability of Seymour Phosphor Bronze to stand such rigorous service is the fact that it is used for just such purposes by a very important part of the electrical industry.

If you wish samples of Seymour Nickel Silver or Phosphor Bronze for test purposes, please call on us at any time.

THE SEYMOUR MANUFACTURING COMPANY, 63 FRANKLIN STREET, SEYMOUR, CONNECTICUT

Specialists in

NICKEL SILVER & PHOSPHOR BRONZE

REMEMBER THE NAME—

SEYMOUR

E. C. Hughes, assistant sales manager, abrasive division, Worcester.

Oakite Products, Inc., New York.—Booth H-10.

Oil Well Supply Co., Dallas, Tex.—Booth E-16.
(United States Steel Corp. Subsidiary)
Exhibiting: See "United States Steel Corporation Subsidiaries."

Tinius Olsen Testing Machine Co., Philadelphia.—Booth A-15.
Exhibiting (in operation): Several universal testing machines, new electronic high magnification recorder, Tour-Marshall stiffness tester, Ballentine hardness tester, compression machine with hydraulic-support weighing system, vibro-electric dynamic balancing machine, and various instruments.
In attendance: R. B. Lewis, chief engineer; B. L. Lewis, sales engineer; B. E. Ohlson, sales engineer; W. M. Patterson, research engineer; and T. L. Richards, sales engineer.

Page Steel and Wire Division of American Chain Co., Inc. Monessen, Pa.—Booth E-32.
Exhibiting: Complete line of gas welding wires and electrodes, both carbon steel and stainless steel, together with line of stainless steel wires and shapes for mechanical purposes.
In attendance: W. H. Bleecker, E. J. Flood, W. A. Berner and J. J. Flaherty.

Park Chemical Co., Detroit.—Booth G-32.

Parker-Kalon Corp., New York.—Booth K-7.
Exhibiting (in operation): Parker-Kalon line of self-tapping screws and fastening devices will be shown and demonstrated. Tests made on the holding power of self-tapping vs. machine screws, bolts and nuts under stresses of tension, shear and vibration, evolution of the screw from prehistoric times to modern fastening devices will be shown by actual specimens.
In attendance: Chas. S. Trott, sales manager; Roland Roe, sales engineer; and A. W. Meader, sales engineer.

The Partlow Corp., New Hartford, N. Y.—Booth I-24.
Exhibiting (in operation): Electric temperature controls; gas temperature controls; thermometers.
In attendance: H. W. Partlow, president; H. W. Partlow, Jr., engineer; A. M. Stock, vice-president; B. L. Finn, Chicago representative; and O. Stirling, Detroit representative.

Pennsylvania Salt Mfg. Co., Philadelphia.—Booth K-10.

Perfection Tool & Metal Heat Treating Co., Chicago.—Booth N-4-A.
Exhibiting: Samples of work done.
In attendance: John Hulting, president; Oscar Hult, secretary; and A. S. Eves, vice-president.

Plibrico Jointless Firebrick Co., Chicago.—Booth I-8.

Radon Co., Inc., New York.—Booth B-19.
Exhibiting: Radiographs of castings, etc., that have been taken using radium capsules for taking radiographs.
In attendance: Thomas J. Gearing, president; Joseph A. Kelly, vice-president; George T. Taylor, sales manager; and R. G. Fordyce, president of Radium & Radon Corporation.

Republic Steel Corp., Massillon, Ohio.—Booth D-3.
Exhibiting: Leading applications of "Agathon" alloy steels, "Enduro" stainless and heat-resisting steels, "Republic Double Strength" steel and "Toncan" copper-Molybdenum-iron.

An interesting feature will be a miniature farm display, showing applications of Republic steels in the agricultural industry. Tractor parts from "Agathon" alloy steels will be shown, also a drop-test tank and special sections of "Republic Double Strength" steel. A working model of an oil well drilling rig will call attention to Republic's products for the petroleum industry. Automotive applications will be represented by displays of transmission and differential gears, by forgings and by various stainless steel products. An interesting display of ball and roller bearings will be included. Airplane parts from leading manufacturers will be exhibited. Displays of alloy steel tools will be prominent. "Enduro" products will include sheet and strip, tubing, bolts and nuts, architectural sections, kitchen equipment and fabricated units used in leading industries. Samples of "Toncan" iron pipe and sheets, of Republic electric weld pipe, and of cold drawn sections will also be seen. Other items to be shown include products of Republic's wire division; "Electrunite" boiler tubes and conduit of Steel & Tubes, Inc., a subsidiary; air-conditioning cabinet by Berger Mfg. Co., and railroad specialties such as tie plates, screw spikes and clamp bolts.
In attendance: R. J. Wysor, exec. vice-pres. and gen. mgr.; N. J. Clarke, vice-pres. in charge of sales; A. E. Walker, gen. mgr. of sales; N. W. Foy, asst. gen. mgr. of sales; L. S. Hamaker, vice-pres. Berger Mfg. Co.; J. M. Schlendorf, mgr. of sales, alloy steel div.; W. H. Schmid, G. F. Hess, asst. mgrs. of sales, alloy steel div.; S. A. Knisely, adv. and sales promotion mgr.; C. W. Ruth, asst. adv. mgr.; H. H. Oldham, adv. dept.; W. J. Hanna, district sales mgr., Chicago; R. W. Hull, asst. district sales mgr., Chicago; L. J. Simmonds, asst. district sales mgr., Chicago; J. P. Distler, mgr. of sales, wire div.; E. K. Conneely, mgr. railroad sales; Kenneth Murray, salesman, Chicago district sales office; E. C. Smith, chief met.; M. J. R. Morris, chief met., and E. R. Johnson, asst. chief met., central alloy div.; R. S. Archer, chief met., South Chicago works; and H. W. McQuaid, L. N. Kohl, H. W. Miller, A. J. Wilson and H. A. Grove, mets.; V. W. Whitmer, welding engr.; J. S. Adelson, chief met., L. M. Hogan, mgr. of promotion and I. Whitehouse, sales engr., Steel & Tubes, Inc.; C. F. Newpher, mgr. of sales, H. C. Ellison, works mgr., C. H. Ellison and R. S. Klemm, sales engrs., and C. H. Aiken, sales dept., Upson Nut div.; W. T. O'Neill, railroad sales rep.; and from Union Drawn; L. E. Creighton, F. C. Young, B. H. Elliott, R. B. Barnett, J. D. Armour, J. C. Murphy and D. W. McDowell.

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Rex Products & Mfg. Co., Detroit.—Booth K-11.
Exhibiting: Its No. 623 machine, a two stage degreasing unit, in full operation. The solvent used will be "Perm-A-Clor," the new stablized chlorinated solvent. The company offers to clean any samples brought to their booth during exhibit hours. Such samples must be 12 x 15 x 18 in. or smaller.
In attendance: George Amstiss, Sam Crooks, W. W. Davidson, and C. F. Dinley.

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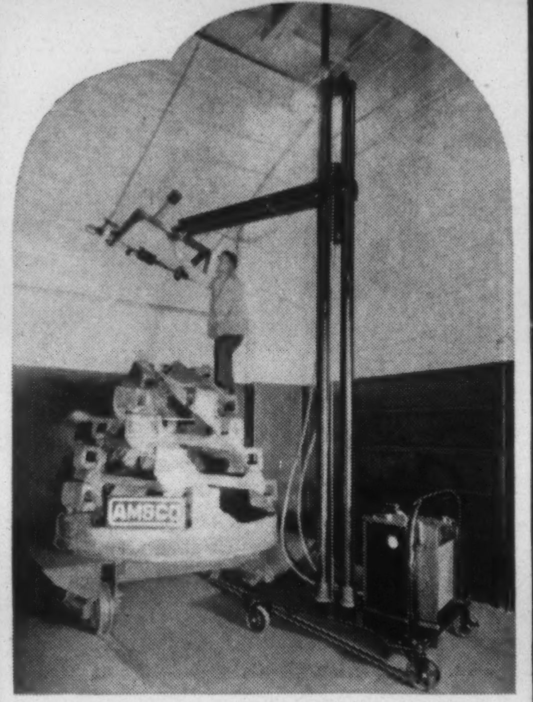

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Rich Mfg. Co., Ltd., Los Angeles.—Booth O-3.
Exhibiting (in operation): The "Strobel Electric Arc Saw." While called a saw, the saw itself, of a soft alloy steel, does no actual cutting. It acts as one pole of the low voltage, high amperage current while the table on which the metal to be cut rests acts as the other pole. The electric arc jumps in a uniform line from the teeth of the saw to the material to be cut. As the intensity of heat through the material is high, and the consequent rate of travel almost instantaneous, the arc is concentrated at any one point for only an instant. The speed of the saw is automatically adjusted to the hardness of the material to be cut, with a minimum speed of over 5000 r.p.m. As the arc does the work, and the teeth of the saw merely act as a carrier and a guide for the current, hardness of the material has no effect nor is the temper or molecular structure destroyed. All known metals and alloys of metals have been quickly and perfectly cut by Karl Strobel's new invention.
In attendance: A. C. Delevanti, secretary and treasurer, Rich Mfg. Co., Ltd.; and Karl Strobel, inventor of the Strobel Electric Arc Saw and president of the Karl Strobel Corp.

Rodman Chemical Co., Verona, Pa.—Booth N-19.
Exhibiting: Carburizing compounds; quenching oil.
In attendance: Hugh Rodman, manager; and O. T. Muehlemeyer, Chicago representative.

John A. Roebling's Sons Co., Trenton, N. J.—Booth B-42.
Exhibiting: Wire rope and wire; insulated wire and cables; wire rope fittings; and woven wire fabrics.
In attendance: H. A. Wason, sales manager; A. E. Gaynor, assistant sales manager; E. I. Weart, salesman; F. J. Maple, advertising manager; and R. S. Johnston, director of research.

Ruud Mfg. Co., Pittsburgh.—Booth H-23.

Joseph T. Ryerson & Son, Inc., Chicago.—Booth F-12.

Scully Steel Products Co., Chicago. (United States Steel Corp. Subsidiary).—Booth E-16.
Exhibiting: See "United States Steel Corporation Subsidiaries."
In attendance: Geo. Mason, Jr., E. C. Vallette, H. A. Parkin, A. G. Nelson, Walter Schuett, P. A. Blake, S. B. Raney, F. B. Dawson, L. H. Swan, A. W. Johnson, A. A. Verschuur, C. E. Lingenfelter, John Patterson, Louis Granzin, and Geo. McConnel.

Selas Co., Philadelphia.—Booth G-34.
Exhibiting: The following equipment applicable principally in connection with industrial gas heating: (1) New air-gas mixing machines especially designed for atmosphere control under conditions requiring 24 hr. operation; (2) "Refrak-Screen" burners offering positive control of combustion through wide range of fuel pressures; (3) Radiant refractory burners having wide application in process heating with furnaces, ovens and numerous other services featuring flameless combustion; (4) High-pressure gas torches; (5) Refractory ribbon burners affording desired combustion over wide areas; and (6) In addition to the foregoing, several types of standard "Selas" mixing machines will be displayed.
In attendance: Frederic Hess, vice-pres. and gen. mgr.; E. L. Fortin, asst. treas.; E. A. Furkert, Chicago district mgr.; R. C. Jordan, Philadelphia district mgr.; and J. A. Smith, sales engr., Chicago.

Sellstrom Mfg. Co., Chicago.—Booth N-4-B.

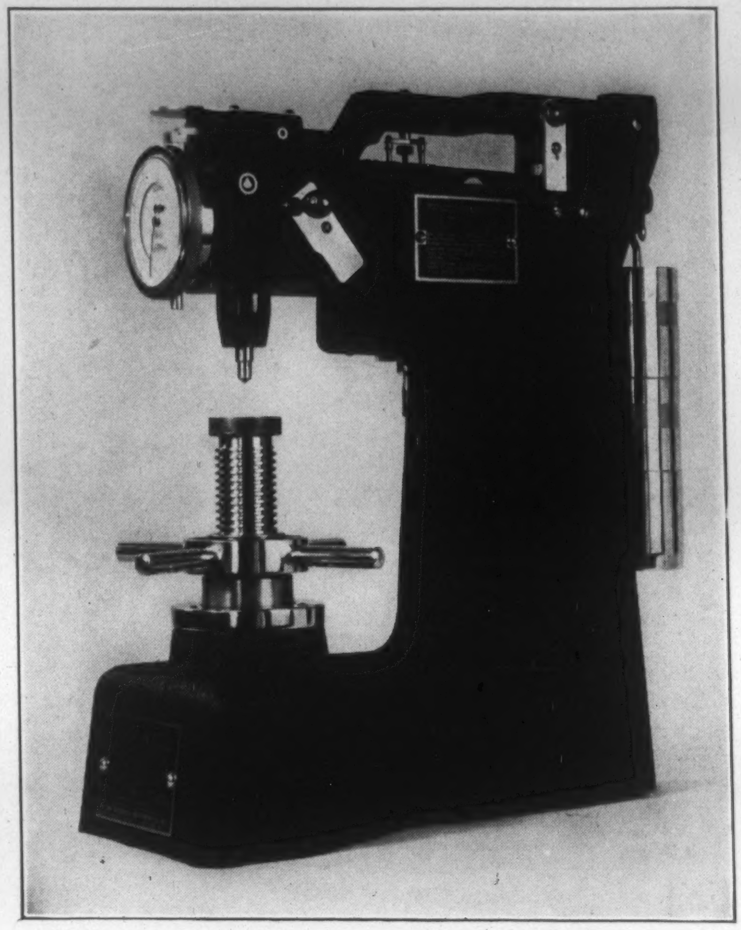
Seymour Mfg. Co., Seymour, Conn.—Booth M-19.

The Shore Instrument & Mfg. Co., Jamaica, N. Y.—Booth M-31.

Sivyer Steel Casting Co., Milwaukee, Wis.—Booth J-10.

South Bend Lathe Works, South Bend, Indiana.—Booth O-15.
Exhibiting (in operation): 9-in. South Bend workshop motor driven lathe; 13-in. South Bend quick change gear underneath motor driven lathe; 16-in. South Bend quick change gear underneath motor driven lathe.
In attendance: M. W. O'Brien, president; J. J. O'Brien, secretary and treasurer; C. B. Burns, salesman; H. B. Burns, salesman; L. O. Stephenson, salesman; J. P. Berg, salesman; E. M. Hanley, salesman; R. S. Young, salesman; F. C. Erhardt, salesman; N. D. Jackman, salesman; R. E. Frushour, salesman; H. W. Lowe, salesman;

"ROCKWELL"
HARDNESS TESTER



Here is an illustration of a new size of "ROCKWELL," having 3" vertical capacity and 5½" depth of throat.

DUE to the fact that we are principally concerned and occupied with the manufacture of "ROCKWELL" Hardness Testers, we are continually at work trying to improve them as to sensitivity, accuracy and durability. No year goes by without several changes, each one of which makes it in some way a better machine.

When you realize that this has been going on for ten years, you will understand how primitive the earliest models are in comparison with the "ROCKWELL" as we now build it.

We have kept our past customers in mind, for most of these improvements can be incorporated during a factory overhauling of any of our testers made during the past 8 years.

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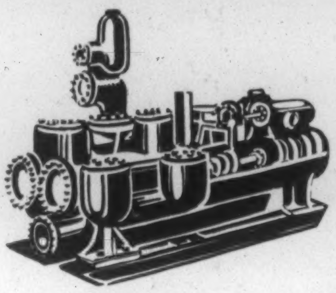
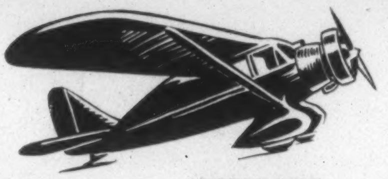
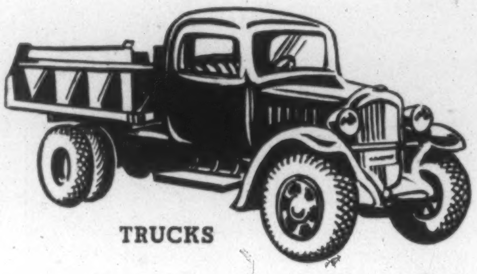


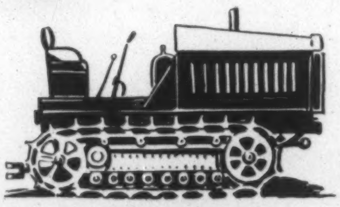
PUMPS



AIRPLANES

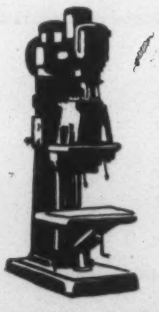


TRUCKS

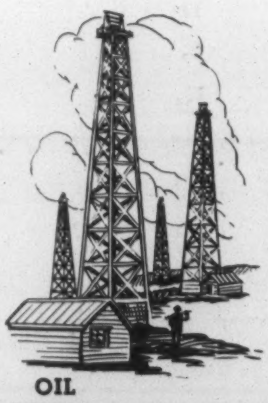


TRACTORS

SPEED REDUCERS



MACHINE TOOLS



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FOR the first time in this country Nitricastiron, cast centrifugally, is available to users of parts requiring maximum wear resistance. Nitricastiron, which has made phenomenal service records for the past five years in Europe, can now be applied to your own equipment—especially engine cylinder liners, pump and compressor liners, bushings, oil well equipment, airplane, automotive and tractor parts and machine tools.

In spite of its unbelievable hardness, Nitricastiron has a very low friction coefficient, due to the nodular graphite throughout its matrix. This aids in the development and maintenance of a continuous oil film over all Nitricastiron working surfaces.

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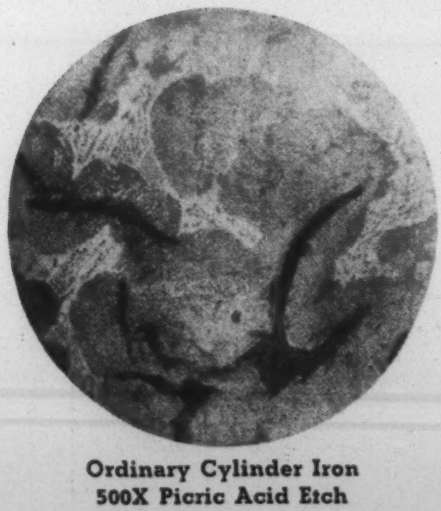
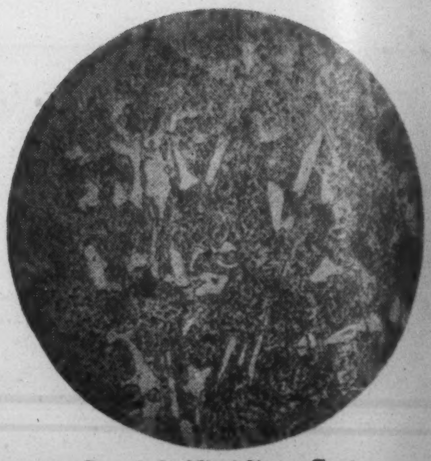


Ordinary Cylinder Iron
500X Picric Acid Etch



Special Nitriding Cast Iron 500X Picric Acid Etch

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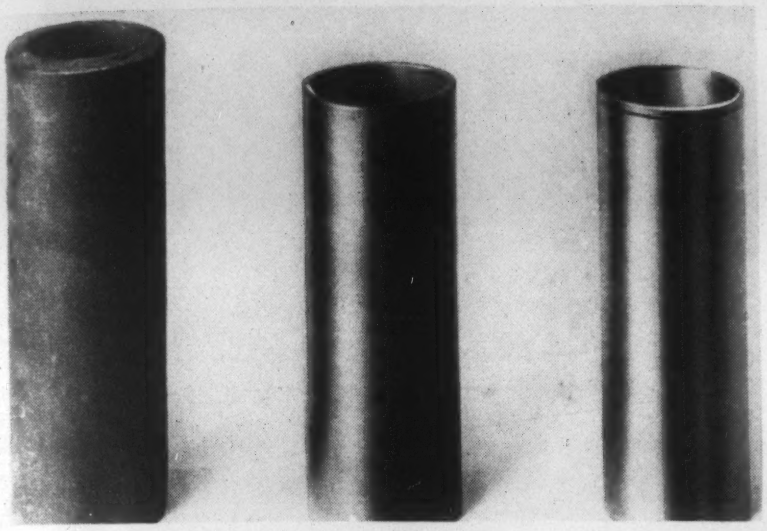
WEAR RESISTANCE



(Left) Typical Sleeve as cast, rough machined ready for nitriding and Sleeve as finished

Centrifugally Cast Nitricastiron used for Many Types of Tubes, Sleeves and Bushings Over a Wide Range of Sizes

At Chicago
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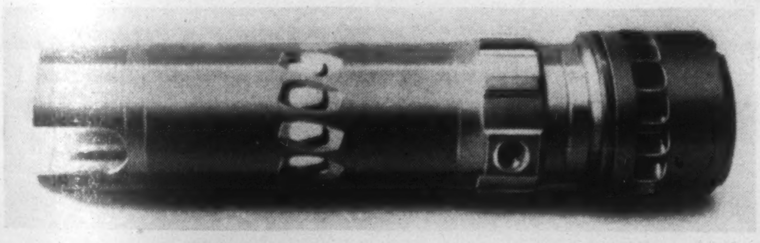
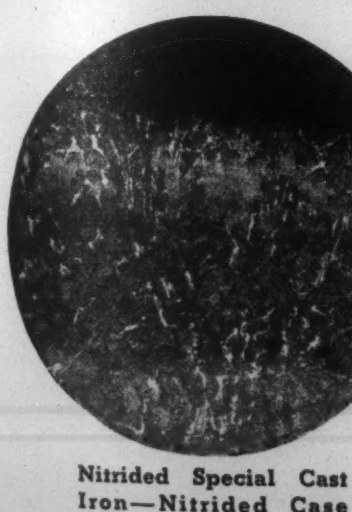
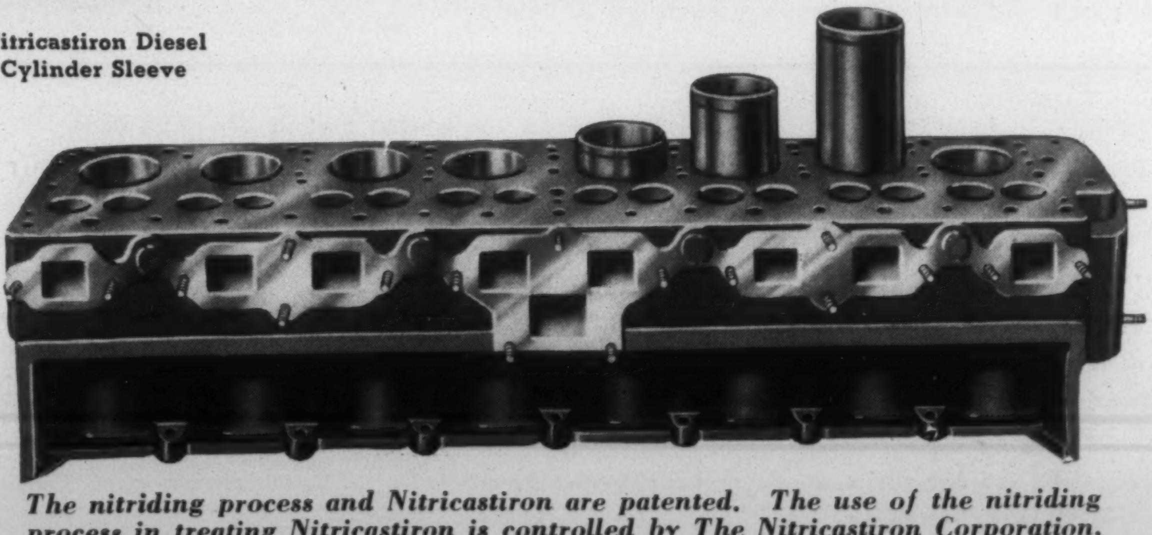


Nitricastiron Diesel Cylinder Sleeve



Nitrided Special Cast Iron—Nitrided Case 100X Picric Acid Etch

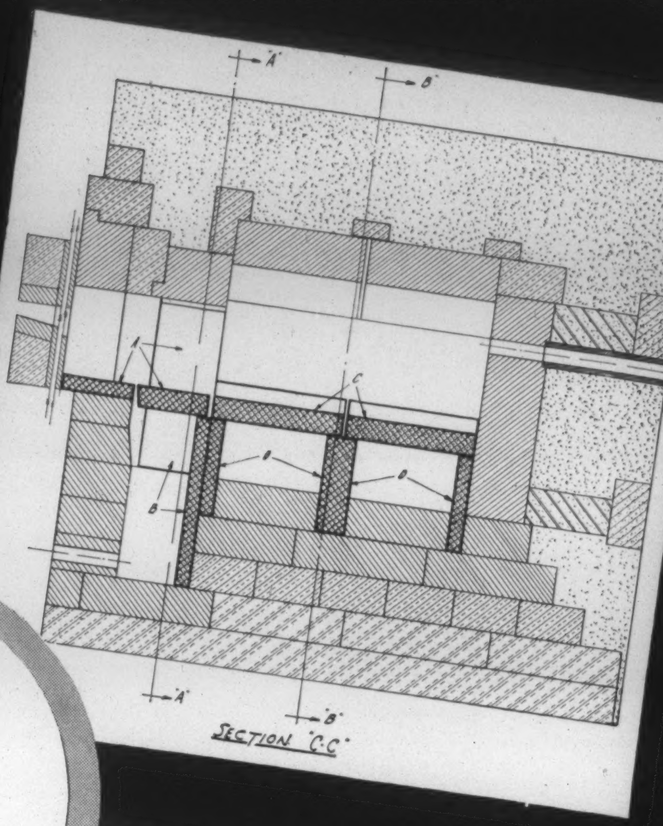


The nitriding process and Nitricastiron are patented. The use of the nitriding process in treating Nitricastiron is controlled by The Nitricastiron Corporation.

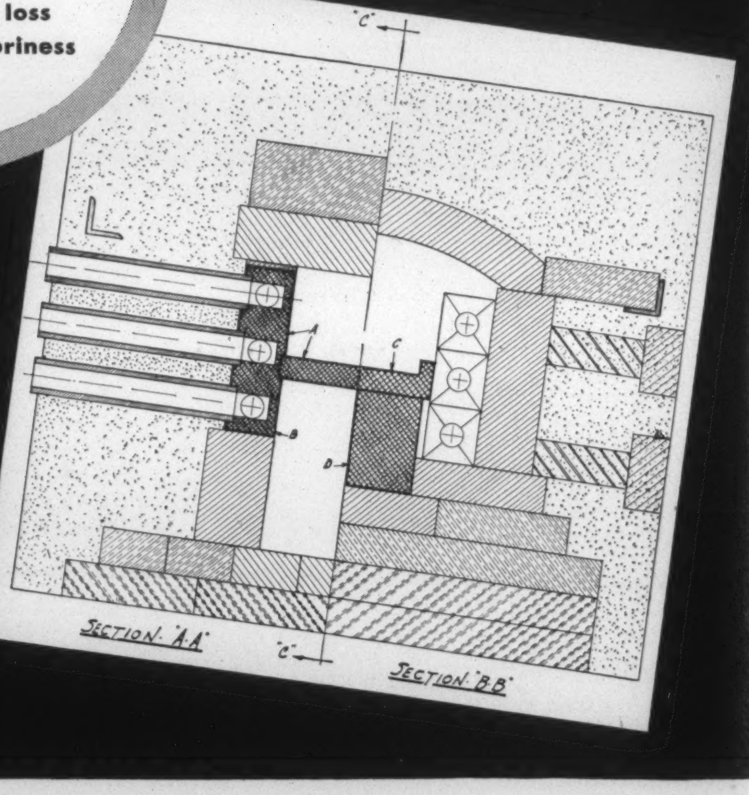
NITRICASTIRON CORPORATION
[illegible] PARK AVENUE, NEW YORK

All 5 distinctive properties of "CARBOFRAX" are factors

IN SUCCESSFUL
CONTROLLED ATMOSPHERE



1. High thermal conductivity
2. Strength at high temperature
3. Resistance to abrasion
4. Low spalling loss
5. High refractoriness



▨ "CARBOFRAX"—*indicates location of "Carbofrax"*

THE drawing of a typical controlled atmosphere, electrically heated furnace is shown above. "Carbofrax" is used in the various marked sections because of a particular property or combination of properties.

A—*Floor and sidewalls of throat.* Here "Carbofrax" is used principally because it will resist abrasion from the work as it is put into and taken out of the furnace.

Notice particularly the opening between the floor tile in this throat, through which the curtain flame issues. It is important that this opening be kept at its original size. "Carbofrax" tile maintain the proper opening because of their resistance to spalling.

B—*Combustion chamber lining.* "Carbofrax" is used because of its high refractoriness and strength at high temperatures. It will not soften or fuse under the high temperatures encountered in this section of the furnace.

C—*Hearth.* "Carbofrax" is used for the hearth because of its high thermal conductivity (which assures sufficient bottom heat for the work), its resistance to abrasion and its strength at high temperatures.

D—*Piers or hearth supports.* "Carbofrax" is used because of its strength at high temperatures and its resistance to spalling.

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Refractory Division
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TRIPLE-CONTROL HUMP HARDENING

The heat-treater has under triple control complete control of the hardening furnace.

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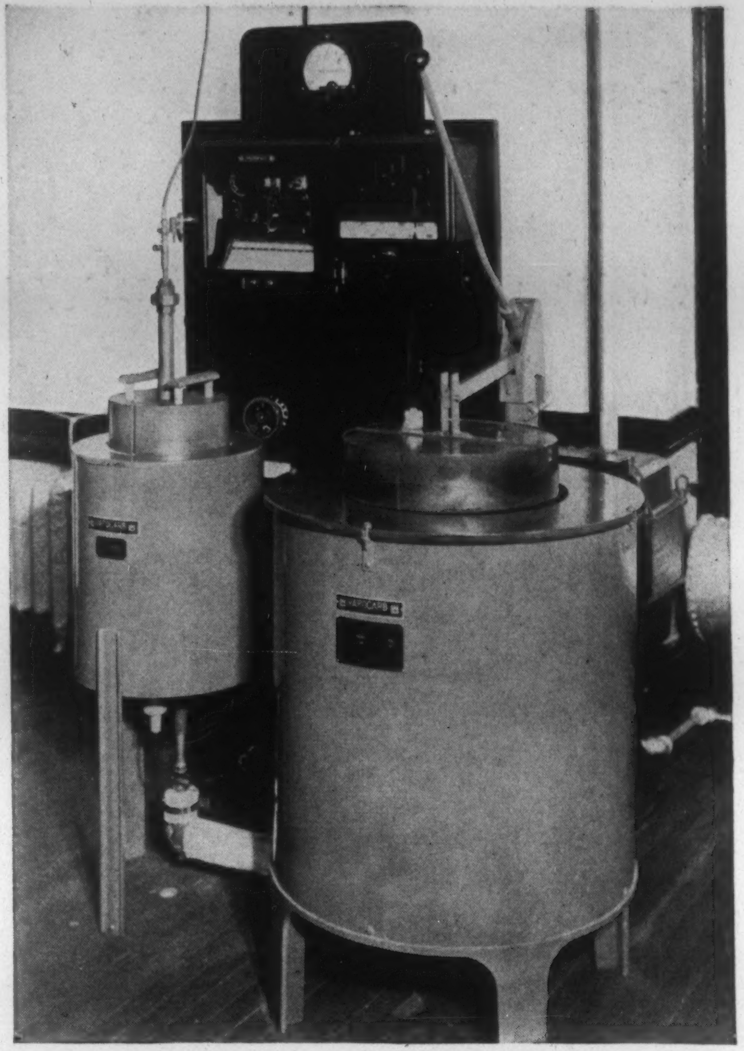
Automatic control of the rate of heating brings all sections of each piece up to the critical, through the critical and on up to the quench point together. The tool really sets its own rate of heating; distortion is reduced to the practical vanishing point.

The Hump Method Control of Quench locates and records the critical range, and records the quench point. It enables heat-treaters either to duplicate quench points, or to vary them accurately and positively.



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On very dense loads, a new Homo Tempering Furnace has great productive capacity. The famous Homo uniformity, on which the success of this method rests, is not affected by a step-up in speed—work has the same close Brinell limits that Homo-Tempered work has always had. The only difference is a sharp cut in the cost of fine tempering of extra-dense loads.

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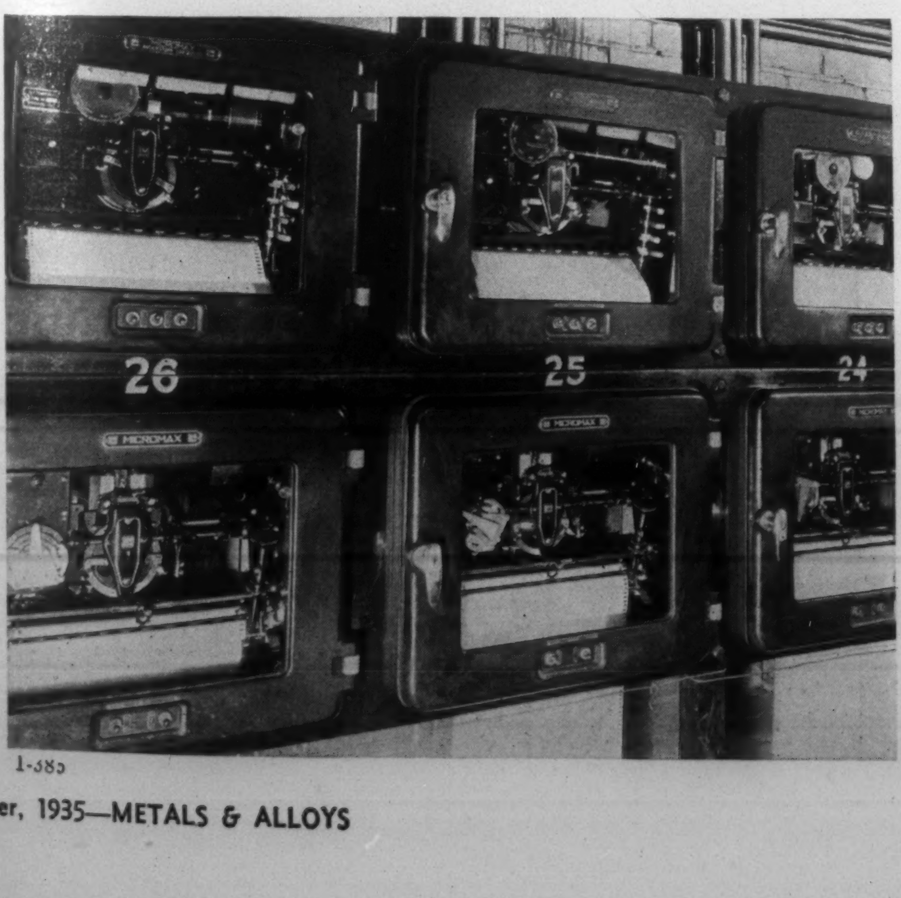

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Its Mining, Production, Technology and Applications

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Pratt Institute, Brooklyn, N. Y.

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A. C. S. MONOGRAPH NO. 51

A COMPREHENSIVE survey of the various phases of the production of tin from its ores to its commercial application. The history, physical and chemical properties, and the production, distribution, and consumption of the metal have been presented and discussed from the viewpoint of the chemist, the metallurgist, and the chemical engineer rather than from the viewpoint of the mining engineer or the mechanical engineer. Secondary tin and detinning of tin plate scrap has been treated from the economic as well as from the metallurgical and chemical viewpoint.

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Chapter 1. History.
Chapter 2. Physical and Chemical Properties of the Metal.
Chapter 3. Production, Distribution and Consumption.
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Chapter 5. Mining and Ore Dressing.
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Chapter 7. Gaseous Reduction.
Chapter 8. Electrolytic Refining.
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Chapter 10. Alloys.
Chapter 11. Hot Dipped Coatings.
Chapter 12. Foil and Collapsible Tubes.
Chapter 13. Compounds.
Chapter 14. Corrosion.
Chapter 15. Corrosion of Tin Plate by Food Products.
Chapter 16. Secondary Tin.
Chapter 17. Detinning of Tin Plate Scrap.
Chapter 18. Analytical Methods.

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The Spencer Turbine Co., Hartford, Conn.—Booth H-11.
Exhibiting: A complete line of turbo compressors, multi stage and single stage, and also low speed and high speed units. One blower delivering air for the furnaces in operation in the gas furnace section. Also a demonstration of heavy duty vacuum cleaning for industrial plants.
In attendance: F. A. Wright, special representative; A. W. Peard, manager Chicago office; R. A. Brackett, sales manager, Hartford.

Star Electric Motor Co., Chicago.—Booth M-16.

Steel, Cleveland.—Booth E-34.
Exhibiting: Display board at rear, furniture, etc. Fitted up as rest room for convenience of visitors.
In attendance: C. J. Stark, president and treasurer; J. D. Pease, executive vice-president; E. L. Shaner, vice-president, editor of *"Steel"*; Geo. O. Hays, vice-president, business manager of *"Steel"*; E. C. Kreutzberg, engineering editor; E. F. Ross, associate editor; J. D. Knox, associate editor; A. H. Allen, associate editor; H. B. Veith, associate editor; John Henry, advertising manager; R. C. Jaenke, advertising representative; W. G. Gude, Chicago editor; and L. C. Pelott, western manager.

Steel City Testing Laboratory, Detroit.—Booth L-8.

Steel Publications, Inc., Pittsburgh.—Booth K-12.
Exhibiting: Business papers.
In attendance: D. S. Watkins, vice-president; N. R. Moll, sales manager; H. Milton Reich, sales representative; F. B. Yeager, subscription representative; Charles Longenecker, editor; W. C. Kernahan, sales representative; and D. N. Watkins, president.

Steel & Tubes, Inc., Cleveland.—Booth D-3.

Charles G. Stevens Co., Chicago.—Booth M-8.
Exhibiting: Round and flat wire, tempered, untempered, tinned, galvanized; fine steel wires, and non-ferrous metal wires; stainless strip steel and strip steel specialties; cold drawn steel shapes and non-ferrous metal shapes; genuine Sheffield crucible tool steel.
In attendance: Charles G. Stevens, president and treasurer; W. R. Marsh, vice-president; John B. Stevens, secretary; Charles G. Stevens, Jr.; W. E. Bennett, metallurgist; C. A. Perkins, salesman; R. Evans, salesman; and H. F. Pfaff, salesman.

N. A. Strand & Co., Chicago.—Booth K-24.
Exhibiting: 10 assorted sizes flexible shaft machines 1/8 to 2 h.p., and several small attachments, and several flexible shafts.
In attendance: Clyde W. Blakeslee, sales manager; Oscar V. Strand superintendent; Lew F. Carlton, sales representative; and Wm. Shramek, shipping clerk.

D. A. Stuart & Co., Chicago.—Booth A-4.
Exhibiting (in operation): New "Extreme Pressure Lubricant" testing machines recently developed by outstanding authorities in the engineering world, D. A. Stuart & Co. will demonstrate the load-carrying and wear characteristics of the newly developed lubricating oils and greases now required for the increased speeds and loads of metal working machinery, steel making machinery, and other equipment. One or more of these testing machines will be in operation at practically all times, and visitors are invited to bring plain cans of not less than one pint content of any lubricant in which they are interested, which will be tested fairly and accurately in their presence for load-carrying capacity and degree of wear.

Progress in cutting lubricants will be demonstrated by exhibiting various samples of alloy steel parts of difficult machinability manufactured by the aid of the nationally known Stuart oil products such as "Thred-Kut" and "Thred-Kut" No. 99 alloy steel cutting oil, "Super-Kool" sulpho-chlorinated fatty oil, "Kleen-Kut" soluble, cutting, grinding and Drawing lubricants, "Codol" liquid grinding compound, "Super-Kool" L-Series drawing lubricants, and "Sturaco" extreme pressure (EP) industrial and automotive lubricating oils.

New printed matter dealing with the technicalities of new-type metal working lubricants will be available.

In attendance: T. B. Langdon, vice-president; W. H. Oldacre, vice-president; W. H. Huelster, western sales man-

OFHC
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Oxygen-Free High Conductivity Copper

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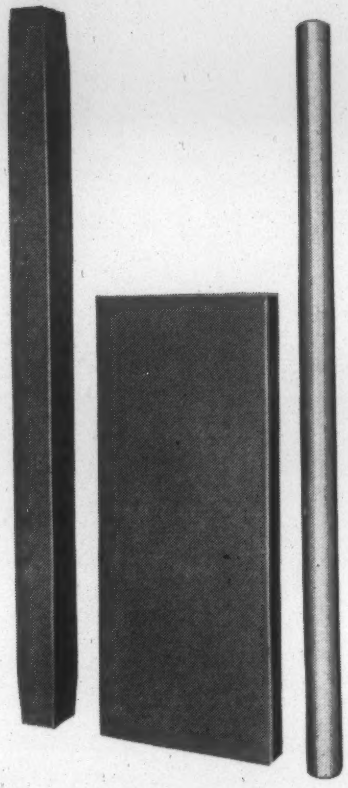
CAKE
and
BILLET



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OFHC copper is supplied to rod, sheet and tube mills in three shapes—Wirebars, Cakes and Billets as illustrated.

All are vertically cast.

Before shipment, the upper end of each OFHC casting is cropped to remove the shrink hole or "pipe" characteristic of sound, gas-free metal. Uniformity and high density are assured by specifying OFHC copper.

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Subsidiary of The American Metal Co., Ltd., 61 Broadway, New York

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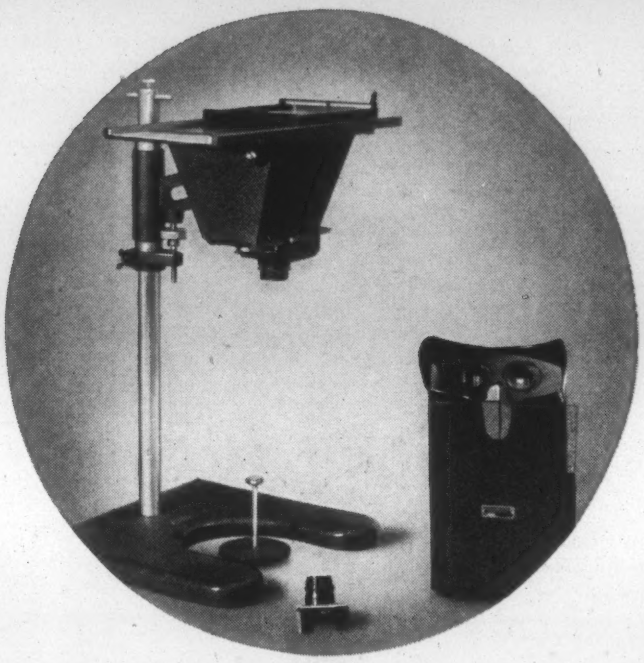
Instead of a plane image, you get length, width and depth with the Ortho Stereo Camera as with the AKW Microscope (below).



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The outfit consists of a newly designed camera and a special stereoscope for viewing stereographs made with it. Write now for complete details. Bausch & Lomb Optical Co., 634 St. Paul Street, Rochester, N. Y.

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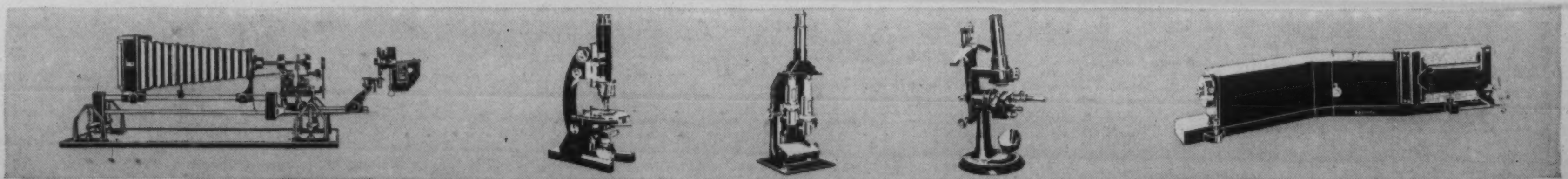
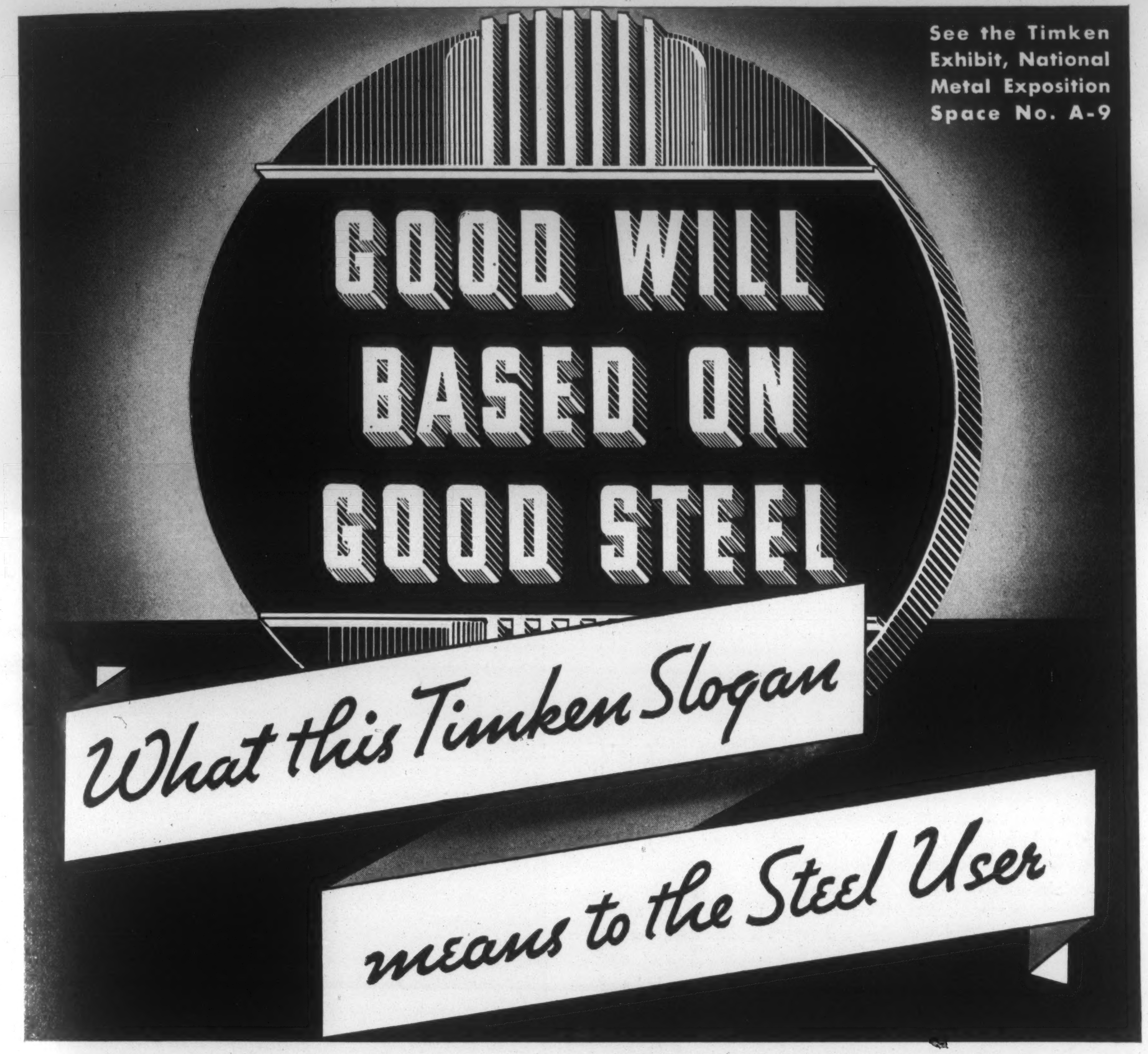


PHOTOMICROGRAPHY ❖ MICROSCOPY ❖ COLORIMETRY ❖ REFRACTOMETRY ❖ SPECTROGRAPHY



What is good steel? And what makes good steel good? As applied to Timken Alloy Steel "good" means, first of all, steel that best meets the individual user's specific requirements—steel that embodies the most suitable combination of chemical, metallurgical and physical characteristics for a particular purpose—steel that exactly matches the user's needs in both service and fabrication. In the second place, "good steel" as interpreted by Timken, means steel that is consistently true to its predetermined grade—steel that has passed every test in the searching system of Timken Quality Control.

Generally speaking, good steel—Timken Steel—means the same to all, namely SATISFACTION—and satisfaction begets good will.

THE TIMKEN STEEL & TUBE COMPANY, CANTON, OHIO

District Offices or Representation in the following cities: Detroit Chicago New York Los Angeles Boston Philadelphia Houston Buffalo Rochester Syracuse Tulsa Cleveland Erie Dallas Kansas City St. Louis Cincinnati Huntington Pittsburgh *World's Largest Producer of Electric Furnace Steel*

TIMKEN ALLOY STEELS AND SEAMLESS TUBING

ELECTRIC FURNACE AND OPEN HEARTH • ALL STANDARD AND SPECIAL ANALYSES

SOME NOTES ON BETHLEHEM ALLOY STEELS

II -- Nickel Steels

Nickel is an alloy which goes into solution in steel (ferrite) and has not only the effect of imparting greater strength but also improves the ductility of any heat-treated part, either by annealing, normalizing or quenching and drawing. Nickel steels have proved their dependability in wide applications over a number of years.

Nickel steels fall in the S. A. E. 2xxx classification. The most widely used nickel steels contain from 3.25 to 3.75 per cent nickel. Other nickel steels, given in the order of their relative popularity, are those containing 5.00 per cent, 1.50 per cent and 0.50 per cent nickel.

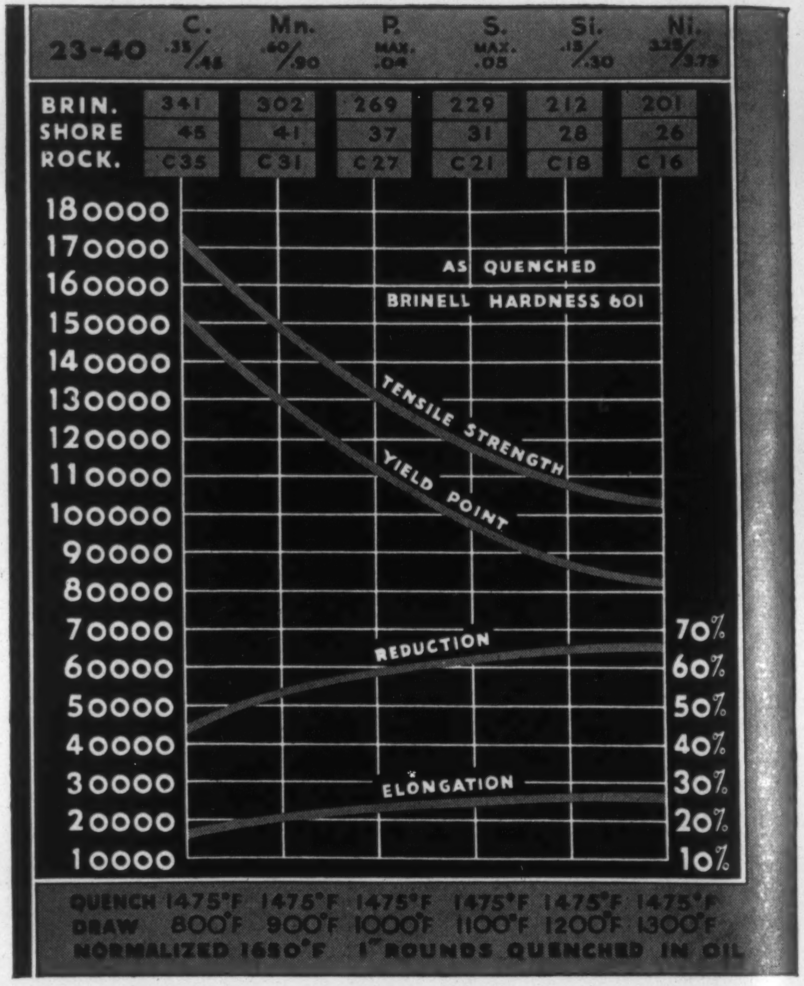
Nickel steels are used in parts where high strength, as measured by yield point, elastic limit, tensile strength and Brinell hardness, must be combined with high ductility and resistance to shock. To realize the maximum combination of properties nickel steels, like all other alloy steels, must be heat-treated.

With a low carbon content (up to 0.25 per cent) the widely used 23xx Series finds application, in the carburized and heat-treated condition, for king pins, rock-drill parts, air-hammer parts, collets, leveler rolls, piston pins, universal joints, shackle bolts, spline shafts, rocker arms, gears of all types, countershafts and studs.

As their carbon content increases, the 23xx steels have wide general industrial uses. In the 0.35 to 0.45 carbon range they are used, in both the water- and oil-hardened condition, for heavy-duty shafts, stud shafts, set screws, studs, bolts, steering knuckles, drive shafts, airplane crankshafts, rocker arms, engine bolts and studs, connecting rods.

With higher carbon—0.45 to 0.55 per cent—the 23xx Series becomes oil-hardening, and is used generally for parts requiring exceptional strength, such as heavy-duty gears, pinions, shafts, axles, spindles.

The 25xx steels, containing 5.00 per cent nickel, are carburizing steels. They combine excellent wearing surface with an extremely strong, ductile and shock-resisting core. They are useful for unusually heavy-service parts, such as truck and bus gears, spline shafts, piston pins, countershafts, drive gears, airplane-engine parts. In the heat-treated condition, without carburization, the toughness of these steels lends them to such applications as piston pins for hammers and turbine blading.



★ *Physical properties of S. A. E. 23-40, a reliable and popular nickel steel.* ★

Nickel steels containing 0.50 and 1.50 per cent nickel (20xx and 21xx) are ordinarily used, in the lower carbon ranges, for carburized parts; they possess greater toughness than carbon steels under parallel conditions, being used extensively for service gears. They are used also, without carburizing, for such parts as engine bolts, staybolts and rivets, and for locomotive spring-rigging.

For highly stressed and reciprocating parts of locomotives nickel steel of the following composition is rapidly coming into use: carbon, 0.20 to 0.30 per cent; manganese, 0.75 to 0.95 per cent; silicon, 0.15 to 0.30 per cent; nickel, 2.50 to 3.00 per cent. This steel is usually put in service in the normalized and annealed condition; but in the case of locomotive axles some railroads quench and draw.

BETHLEHEM STEEL COMPANY

GENERAL OFFICES: BETHLEHEM, PA.

Wherever Steel Is Made Big-End-Up Molds Do a Better Job!

Teeming a jag of Gathmann big-end-ups at Republic

NOBODY appreciates more than does the buyer that big-end-up methods of ingot production mean finer steels. And when sound, dependable steels are required, he specifies that they be made in accordance with recommended Gathmann practice. The feature that contributes most to the quality of steels so produced is the big-end-up contour of the molds. This characteristic assures a degree of homogeneity and soundness and a surface quality in the ingot and its product that are superior to anything possible with big-end-down methods.

Until quite recently, custom-made ingot molds were considered an unnecessary luxury in tonnage practice. Today, however, the largest plants in the world have their molds designed by Gathmann.

Big-end-up molds are recognized as necessary to economical production of all types of steel, not alone because of the better quality of the steel, but because of the high percentages yielded into first-grade products. Bloom yields from Gathmann type ingots average 82% or better in most practices.

Within the past few months several plants have made comparative tests with Gathmann big-end-up and standard big-end-down molds in casting all of the various types of steel which they produce. In the hundreds of heats (about 15,000 tons) made in these tests, the yields averaged better than three percent increase over the standard practice. This represents a tremendous saving that is particularly impressive when the improvement in the quality of the interior and surface of the product is taken into consideration.

Make your own comparative tests. You will find that modern Gathmann designs and methods will do for your practice what nothing else can — *they will assure dependability with high yields in steel of any specification.*

Visit us at the National Metal Congress — Booth C-23.
We will show you just how much better Gathmann Ingots are.

THE GATHMANN ENGINEERING COMPANY

DESIGNERS OF
INGOTS AND MOLDS SINCE 1909

BALTIMORE, MARYLAND

BERYLLIUM

Its Production and Application

By Zentralstelle fuer wissenschaftlich-technische Forschungsarbeiten des Siemens-Konzern

Translated by RICHARD RIMBACH *and* A. J. MICHEL

NOT only is this the first thorough treatise on beryllium to appear in English, which fact alone makes it welcome to American metallurgical engineering, but it presents in concise and usable form what might be termed "all about" this coming metal. The authoritativeness of this book arises from the fact that it is essentially an account of ten years' work on beryllium and its alloys by the very men who systematically conducted these researches, augmented by reports contributed by other workers in this field. This book will be found indispensable not only to workers in the more obvious field of light-metal alloys, but equally to those interested in the alloys of the heavier metals.

CHAPTERS

Introduction.
Outline of the Research Program on the Production and Uses of Beryllium.
The Analytical Chemistry of Beryllium.
The Occurrence of Beryllium.
The Thermal Reduction of Beryllium.
Investigation on the Dressing of Raw Beryl and on the Production of Beryllium Salts Suitable for Electrolysis.
Electrolytic Production of Beryllium.
The Influence of Bath Composition and Bath Temperature on the Stock-Goldschmidt Siemens & Halske Method for the Production of Beryllium.
Physical and Chemical Properties of Beryllium.
The Production of Electrolytic Deposits of Beryllium by High Temperature Electrolysis.
Direct Electrolytic Production of Beryllium Alloys.
The Structure of Beryllium-Copper Alloys.
Physical Properties and Age Hardening of Beryllium Copper Alloys.
Changes in the Electrical Conductivity and the Volume During the Age Hardening Beryllium-Copper Alloys.
The Changes in the Modulus of Elasticity During the Age Hardening Beryllium-Copper Alloys.
Changes in the Microstructure of Beryllium-Copper Alloys Due to Age Hardening.
X-Ray Investigation of the Age Hardening Process in Beryllium-Copper Alloys.
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ager; W. M. Duncan engineering department; H. P. Harris, engineering department; E. B. Gratton, Chicago and Wisconsin representative; G. F. Stanford, Chicago and Illinois representative; P. Slivinski, Chicago representative; E. J. Graham, Chicago representative; W. E. Marble, Chicago representative; C. H. Baker, Ohio representative; and B. W. Deacon, Michigan representative.

Surface Combustion Corp., Toledo.—Booth H-25.
Exhibiting (in operation): De Luxe high speed furnace (live display); burner display tables; photograph rack; air heater and control unit; cyanide pot furnace; unit heater; walking beam furnace model.
In attendance: F. H. Adams, vice-president and general manager; C. B. Phillips, vice-president and sales manager; W. M. Hepburn, vice-president and chief engineer; H. M. Heyn, assistant sales manager; E. G. DeCoriolis, engineer; W. O. Owen, district manager; W. F. Herdrich, district manager; D. H. Bacon, advertising manager; H. W. Schramm, engineer; E. C. Stephenson, engineer; and C. C. Edelen, engineer.

Sutton Engineering Co., Pittsburgh.—Booth L-29.

C. J. Tagliabue Mfg. Co. Brooklyn.—Booth I-11.
Exhibiting: In the pyrometer department it will have mounted on a six-sided display a complete line of indicating, recording and controlling instruments featuring the photoelectric cell and reflecting galvanometer; the "TAG Indicating Potentiometer Controller" with red, white and green color screens that signal the observer from at least 40 ft. away with a brilliant line of red, white or green light, as to the condition of the furnace; the new 2-position "Recorder-Controller" which will unquestionably be very interesting to the users of pyrometers because of its very simple construction, great sensitivity and the fact that it is always controlling.

In addition, there will be shown the "TAG Program Controller" made up in two units in conventional controller cases: One as an indicator which can be used with a motorized cam and slide-wire serving as a program controller and by turning a switch the controller unit can be used as a straight "on-off" or 2-position controller. This program controller is capable of very faithfully carrying out the prearranged time temperature cycle designed for any particular process. There will also be shown the "Recorder-Controller" of the non-hunting, non-drifting proportional type and the "Multiple Recorder" which will record up to 12 records on a wide, chart, as well as the simple "Indicating Potentiometer Pyrometer" and "Resistance Thermometer Controller." It will also show the new 12-point, all inclosed, dust and fume proof "Rotary Switch" as well as thermocouples. On the same panel will be shown various other "TAG" instruments such as recording thermometers, indicating thermometers, recording flow controllers, the new magnetic clutch and valves, etc.

In attendance: William Printz, division sales manager; C. O. Fairchild, director of research and E. Wacker, assistant general sales manager, as well as Mr. Kerr, Detroit office, and Wallace White, manager of Chicago office, with his associates, Messrs. Hurst and Hix; also W. C. Shaw, in charge of service department in the Chicago area.

Tennessee Coal, Iron & Railroad Co., Birmingham, Ala. (United States Steel Corp. Subsidiary).—Booth E-16.
Exhibiting: See "United States Steel Corporation Subsidiaries."

Thermo Control Devices, Inc., Chicago.—Booth L-1.
Exhibiting (in operation): A greatly enlarged demonstrating model of the new "Wheelco" system of temperature control in actual operation; a new line of controlling and indicating meters for temperature and other purposes; such as flow, pressure, speed, gas, etc. entirely different in principle from either the millivoltmeter or potentiometer systems; a new kind of automatic excess temperature control and alarm system for all types of ovens and furnaces; entirely new automatic control systems for ovens and furnaces; several types of indicating pyrometers; automatic alarm systems for diesel engines; diesel engine pyrometers; relays; switches, both hand and motor operated, and all types of auxiliary equipment for pyrometers, such as thermocouples, lead wire, protecting tubes, etc.
In attendance: Leo. W. Wheeler, president; Geo. A. Wheeler, secretary and treasurer; Theo. A. Cohen, vice-

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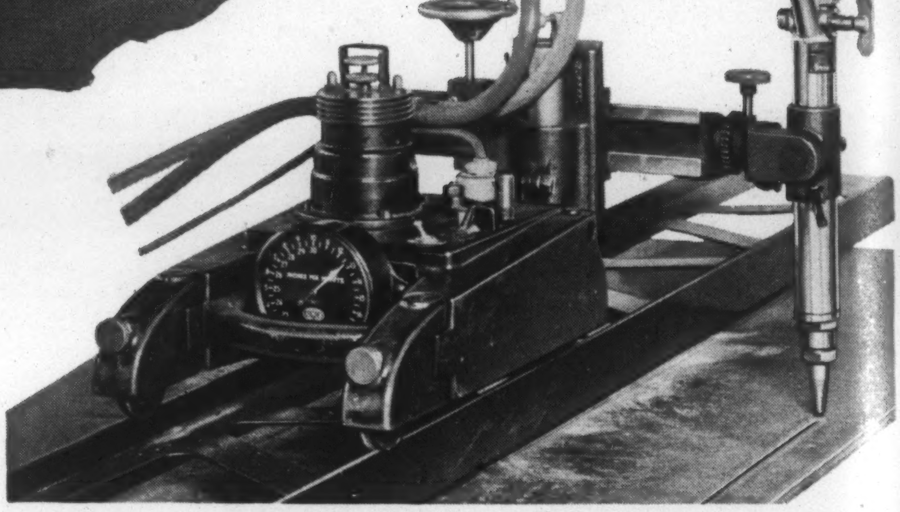
See these OXYACETYLENE Cutting Machines *in* ACTION!

AIRCO-DB No. 6 OXYGRAPH



AIRCO-DB No. 4 RADIAGRAPH

at the NATIONAL METAL EXPOSITION

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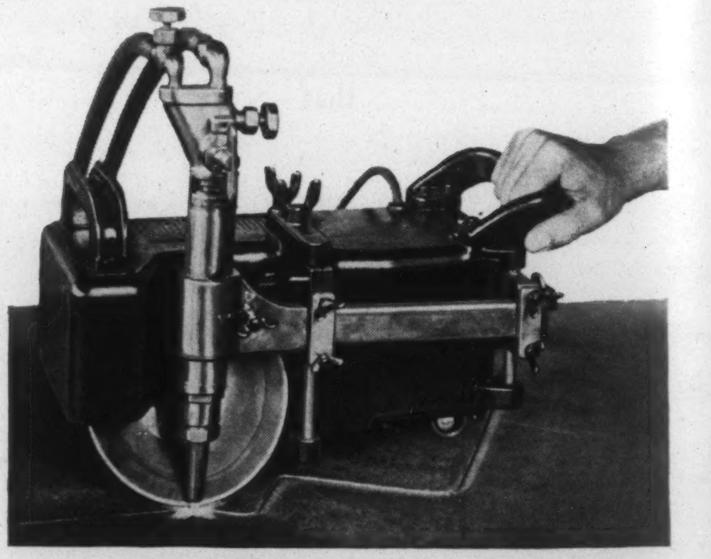
. . . and learn the advantages of flame cutting in the production of an unlimited variety of shapes from steel plate, slabs, billets and forgings.



AIRCO-DB No. 1 TRACTOGRAPH

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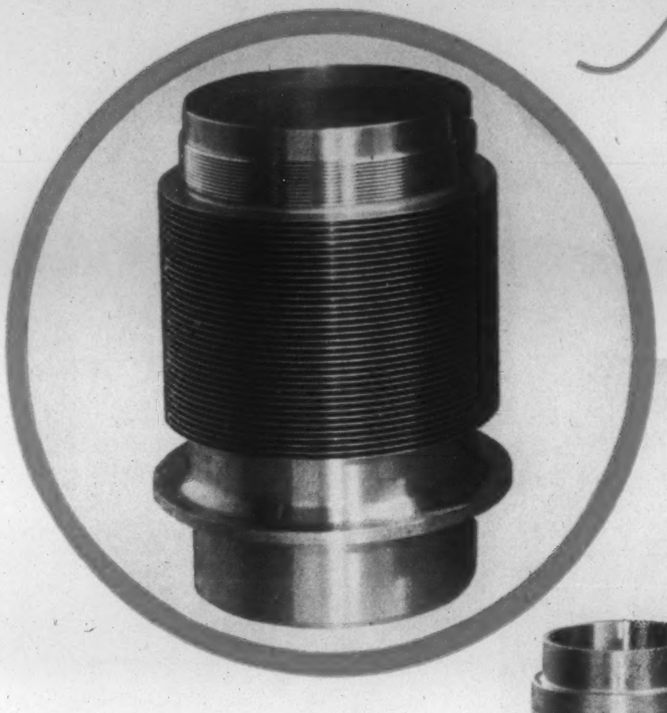
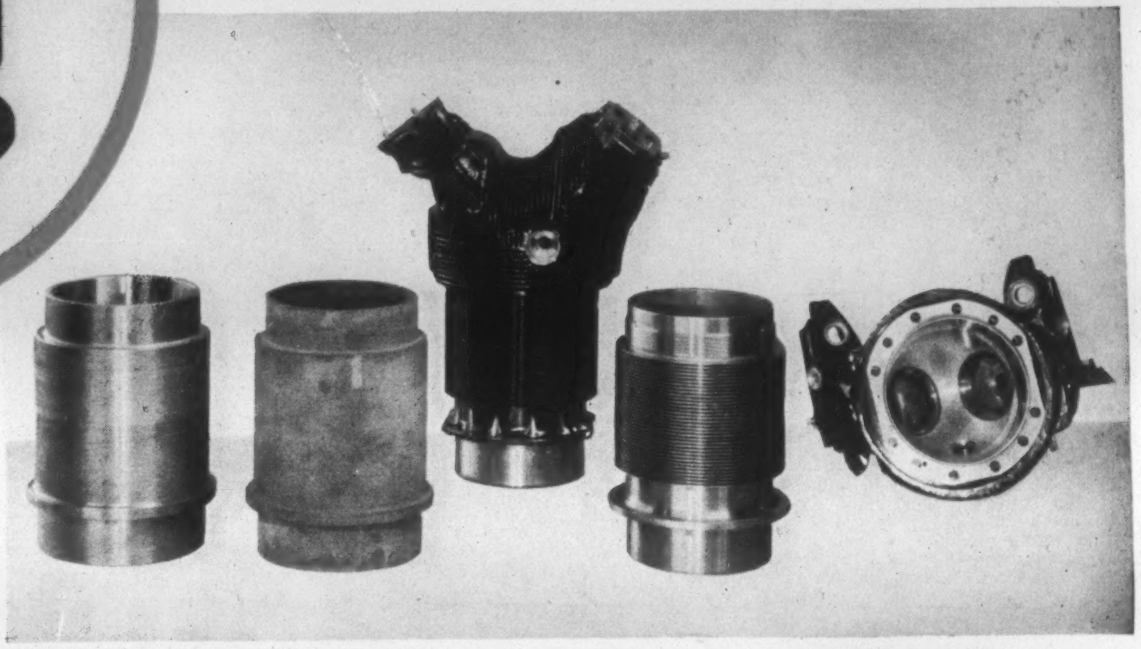
A NATION-WIDE WELDING and CUTTING SUPPLY SERVICE

And Now . . . NITRALLOY Cylinder Barrels for the Latest Series of 750 H. P. WRIGHT CYCLONE ENGINES

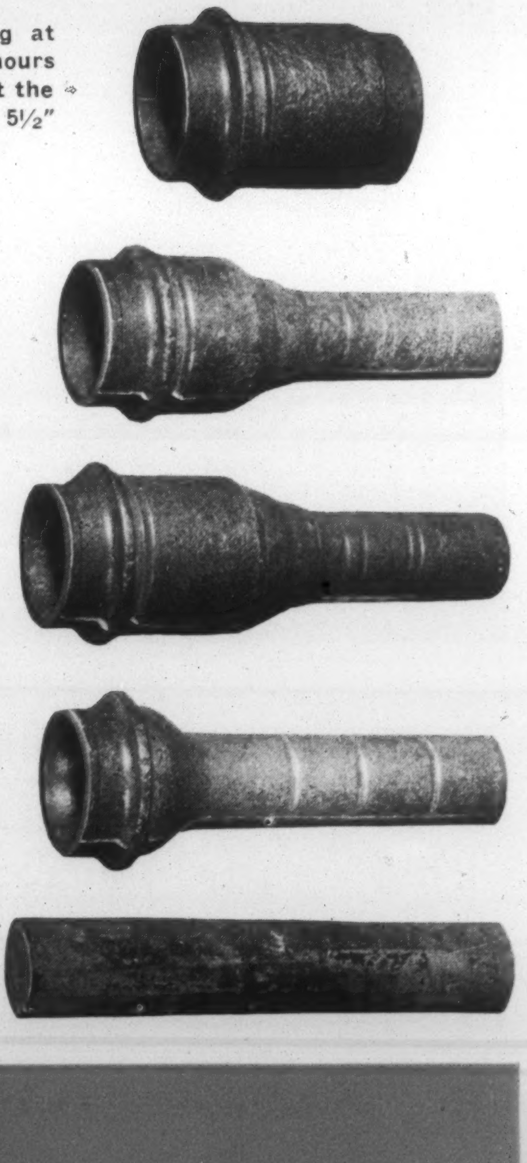


Finished nitrided Nitralloy cylinder barrel before being fitted into aluminum cylinder head.

Photographs courtesy of the Wright Aeronautical Corporation, Paterson, N. J., and Canton Drop Forging Manufacturing Company, Canton, Ohio.



Nitrided Nitralloy cylinder barrel showing forging at left, cylinder barrel after being nitrided for fifty hours and the finished cylinder barrel after machining. At the right, a cylinder barrel showing the stages from 5½" round bar to finished forging.



DEPENDABILITY and advanced engineering design have long been characteristics of airplane engines built by the Wright Aeronautical Corporation.

And now, where high power and high rotated speed present new problems in the design of heavy duty airplane engines, after considerable research and development on the part of Wright Engineers and the Crucible Steel Company of America, it was found that nitrided cylinder barrels considerably increase the life of the engine.

As a result, the latest series of 750 h.p. Wright Cyclone Engines are built with Nitralloy cylinder barrels. After heat treating, quenching and normalizing the forging, the nitralloy cylinder barrel is nitrided for approximately fifty hours to obtain a case of .020 to .030 of an inch and shows a Vickers Brinell test of approximately 800.

Nitralloy, when nitrided from fifty to seventy hours, produces the hardest known steel surface and offers the latest advance in overcoming wear resistance in the presence of severe operating conditions.

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Ludlum Steel Co., Watervliet, N. Y.
Vanadium-Alloys Steel Co., Pittsburgh, Pa.
The Republic Steel Corp., Youngstown, O.

The nitriding process and Nitralloy are protected under patents controlled by

THE NITRALLOY CORPORATION

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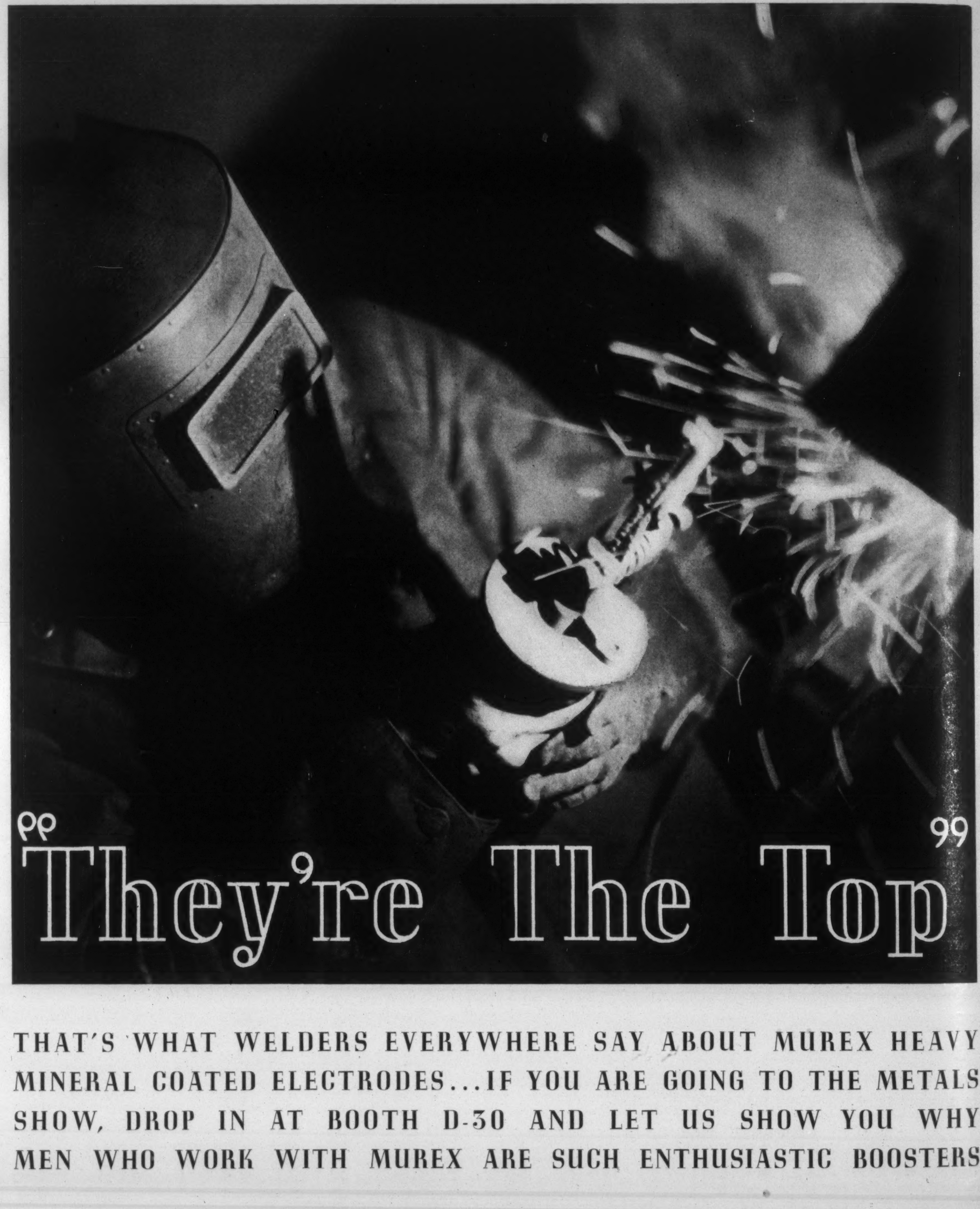

THAT'S WHAT WELDERS EVERYWHERE SAY ABOUT MUREX HEAVY MINERAL COATED ELECTRODES...IF YOU ARE GOING TO THE METALS SHOW, DROP IN AT BOOTH D-30 AND LET US SHOW YOU WHY MEN WHO WORK WITH MUREX ARE SUCH ENTHUSIASTIC BOOSTERS

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HEAVY MINERAL COATED ELECTRODES

Now—eliminate annealing

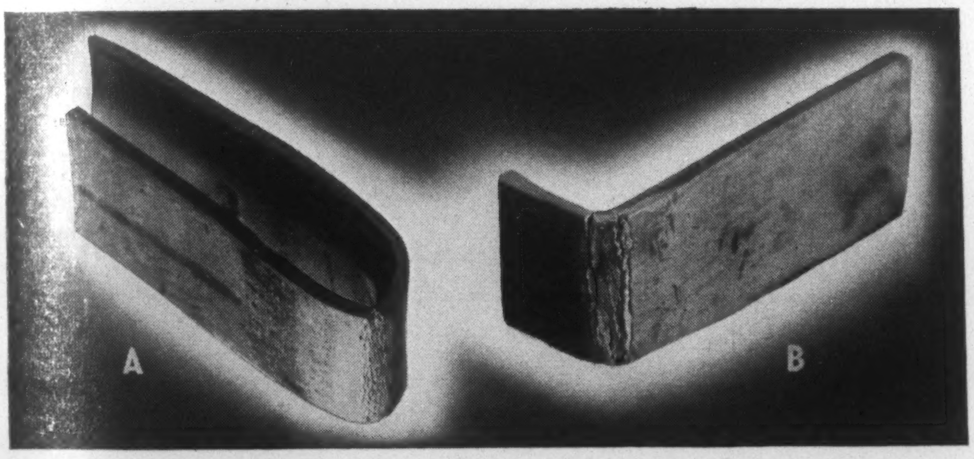
OF WELDED AUSTENITIC CHROMIUM-NICKEL STEEL

with Ferrocolumbium

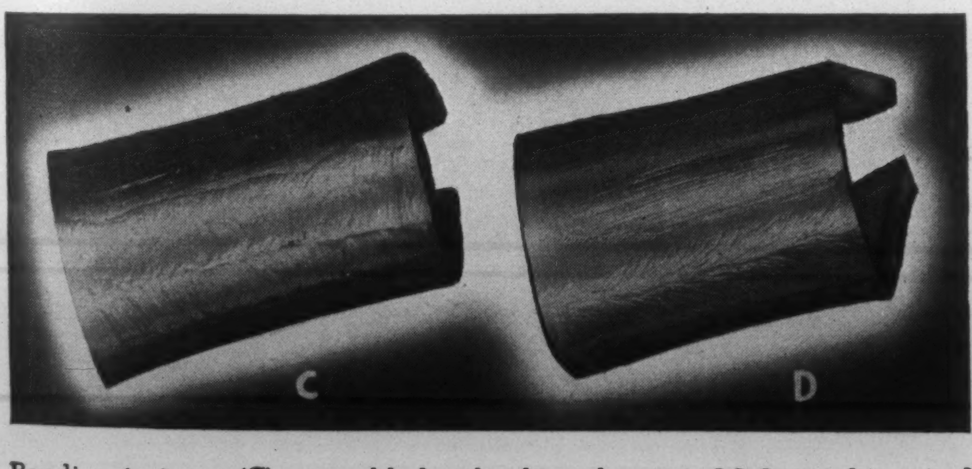
- Ferrocolumbium provides a convenient and enonomical means of adding columbium to chromium-nickel steels. Columbium does not readily burn out to a detrimental degree during welding by any method. Hence columbium-bearing 18-8 stainless steel can be used after welding with columbium-bearing welding rod without subsequent annealing. There is no increased susceptibility to corrosion in or adjacent to the weld seam. The valuable properties of normal 18-8 stainless steel are not impaired.

Columbium inhibits intergranular deterioration of the austenitic chromium-nickel steels when exposed concurrently to high temperatures and chemical corrosion. It makes possible the use of 18-8 stainless steel at temperatures between 1000 deg. F. and 1500 deg. F. without developing intergranular corrosion.

Ferrocolumbium is available from Electro Metallurgical Company. Electromet Metallurgists will gladly further explain its advantages and assist you in its use. The booklet "Effects of Columbium in Chromium-Nickel Steels" will be sent to you on request. Write for a copy today.



Bending tests on (A) arc-welded normal 18-8 stainless steel and (B) oxy-acetylene-welded normal 18-8 stainless steel after boiling for 400 hours in acidified copper sulphate. Note the severe cracking adjacent to the weld seam, showing intergranular corrosion.



Bending tests on (C) arc-welded columbium-bearing 18-8 stainless steel and (D) oxy-acetylene-welded columbium-bearing 18-8 stainless steel after boiling for 400 hours in acidified copper sulphate. Note the complete absence of cracking, showing absence of intergranular corrosion.

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation

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service . . .

Engaging with Carburized, File-Hard Bull Gears . . .

In the files of Horace T. Potts Company, Philadelphia, are literally hundreds of instances of the long service of *Elastuf,* an oil hardened and tempered chromium Vanadium Steel. The trolley car motor pinion illustrated above is typical. After 225,000 miles—five times the average life of pinions made of other steels—it was still in good condition and performing satisfactorily. Note the tooth contour and the fact that the surface shows no breakdown.

Scores of these Vanadium Steel pinions, machined from Elastuf Type A Heat Treated Steel, without heat treatment after machining, are standing up in trolley car service. Their dependability furnishes another instance of the long wearing qualities of Vanadium Steels.

We are always ready to discuss your steel problems, particularly the difficult ones where exceptionally severe service is involved.

Booth A-16
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of vanadium, silicon, chromium, titanium, and silico-manganese, produced by the Vanadium Corporation of America, are used by steel makers in the production of high-quality steels.

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5 Reasons Why

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FOR MANY YEARS, in many thousands of installations, Superex has proved itself the superior block insulation for high-temperature industrial equipment. Recently, it has been made even more efficient, even more resistant to high temperatures than ever before.

Here, briefly, are five important reasons why Superex, used behind refractory or semi-refractory linings, will give you trouble-free service and maximum efficiency and economy.

REASON No. 1

SAFE AT HIGH TEMPERATURES

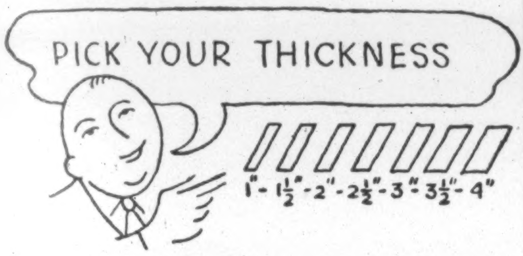
Made of especially selected and calcined diatomaceous silica, blended and bonded with asbestos fibre, Superex has unusual heat resistance. For many years, it has proved its dependability under severe service behind refractory linings in high-temperature furnaces.

REASON No. 2

HIGH INSULATING EFFICIENCY-LESS THICKNESS REQUIRED

Its remarkably low thermal conductivity means that, for the same insulating value, a lesser thickness of Superex is required than any material of equivalent heat resistance.

REASON No. 3



Superex is furnished not only in the thicknesses shown above, but also in any intermediate thickness desired. No waste; you buy only the thickness you need.

REASON No. 4

LOW INSTALLATION COST

Blocks are large (up to 12" x 36"); they are light (23 lb. per cu. ft.). Superex goes on quickly, economically—as much as 3 sq. ft. at a time—with marked savings in labor cost.

REASON No. 5

JOINT LOSSES MINIMIZED

No matter what insulation you use, or how carefully you apply it, there's bound to be heat leakage through joints. Heat passes through joints like water through a sieve.

But with Superex Blocks, because of the large-size units, such losses are reduced to a negligible degree.

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INDUSTRIAL INSULATIONS
For every temperature condition from 400° F. below zero to 3000° F. above.
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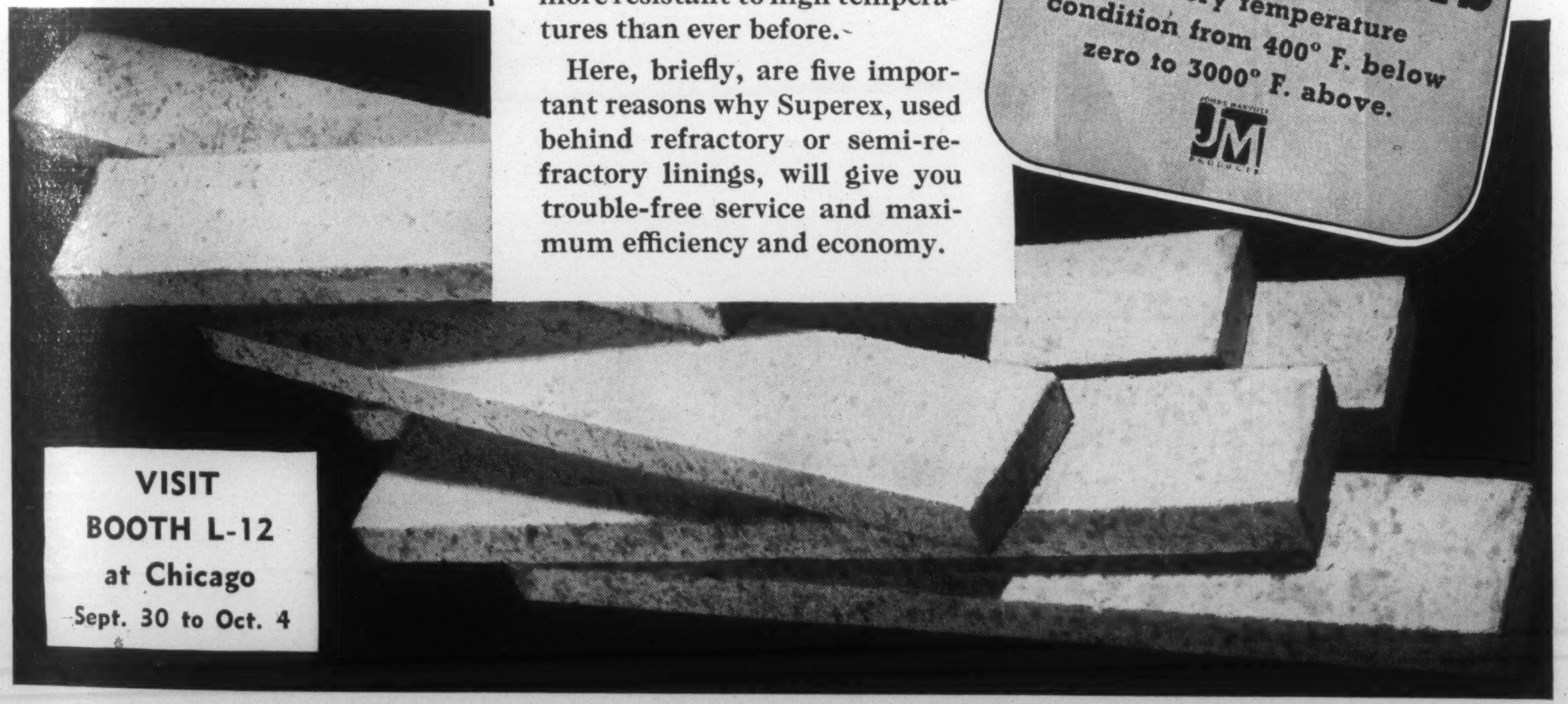

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Sept. 30 to Oct. 4

A Few Uses for Superex

You will find Superex Blocks especially well adapted for the insulation of slab heating, annealing and all types of controlled atmosphere furnaces, producer gas mains, hot-blast stoves, open hearths and regenerators, and boiler furnaces.

Superex is also available in the form of pipe insulation for superheated steam and hot oil and gas lines.

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Send me data sheets on Insulation of Industrial Furnaces and Ovens, including information on Superex Blocks.

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MA-10-35

president and chief engineer; and Richard A. Schoenfeld, vice-president and sales manager.

The Thomas Steel Co., Warren Ohio—Booth E-19.
Exhibiting: Various types of plain and electro-coated cold rolled strip steel, and samples of finished products made from "Thomastrip."
In attendance: H. A. Mentall, general superintendent; W. F. Rummell, sales manager; and J. S. Nachtman, superintendent plating department.

The Timken Steel & Tube Co., Canton, Ohio.—Booth A-9.
Exhibiting (in operation): Exhibit is designed around the idea that out of the ladle comes the uniformly high quality steel for which the company is noted and practically the whole of the back wall will be occupied by a dramatic and colorful presentation of that theme.
In attendance: F. J. Griffith, president; H. H. Timken, Jr., vice-president; F. L. Gibbons, vice-president charge of sales; S. D. Williams, manager tube sales; L. L. Ferrall, metallurgical engineer; R. L. Wilson, metallurgical engineer; R. Atkinson, Detroit representative; J. H. Abbott, Detroit representative; and E. F. Talmage, Chicago representative.

The Titanium Alloy Mfg. Co., Niagara Falls, N. Y.—Booth D-35.
Exhibiting: A number of varieties of steel, iron and aluminum castings, tin plate, strip steel, sheet steel and deep stamping steel, as well as other varieties of medium and high-carbon steels all deoxidized with some form of Titanium alloy, and samples of all the Titanium bearing alloys that it manufacturers as well as ceramics for the enameling trade.
In attendance: W. G. Wellings, chief development engineer, in charge; S. T. Harleman, B. F. Wagner and E. R. Starkweather.

The Udylite Co., Detroit.—Booth A-1.

Una Welding, Inc., Cleveland.—Booth B-31.
Exhibiting (in operation): Full automatic arc welding head in operation showing high speed production welding.

Una welders for automatic and manual welding.

Una welding rods of all types such as shielded arc rods, high speed production rods general purpose rods, and rods used for maintenance work.
In attendance: N. T. Jones, vice-president and general manager; E. W. Kronbach, secretary and treasurer; L. S. Burgett, engineer; C. M. Schaub, engineer; and J. S. Vogler, engineer.

Union Carbide Co., New York.—Booth I-1.

United States Steel Corp. Subsidiaries, New York.—Booth E-16.
Exhibiting: U S S stainless and heat resisting steels, U S S high tensile steels, alloy, and open hearth carbon grades. An actual demonstration of welding, using Premier Tested Welding wire, and U S S 18-8 Stainless Coated Welding wire. Products, welding wires, manufacturing wires, cold rolled strip steel, springs and cold finished steel bars. Stainless pipe and tubular products, polished samples of stainless pipe and tubing, showing various shapes, polishes, and physical tests. Sheets, multigrip floor plate, and samples of products fabricated from alloy and special steels.
(Names of representatives in attendance listed under individual company names.)

Universal Steel Co., Bridgeville, Pa.—Booth O-19.

Vanadium Alloys Steel Co., Pittsburgh.—Booth B-27.

Vanadium Corp. of America, New York.—Booth A-16.

Vapofier Corp., Chicago.—Booth L-23-A.

Victor Saw Works, Inc., Middletown, N. Y.—Booth L-41-A.
Exhibiting (in operation): Victor Moly (Molybdenum) hack saw blades. 1-6 inch Racine hack saw machine in operation.
In attendance: John J. Wallace, assistant sales manager; and R. B. Jones, Chicago district manager.

Vulcan Crucible Steel Co., Aliquippa, Pa.—Booth M-23.

Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.—Booth M-20.

The Welding Engineer Publishing Co., Chicago.—Booth K-19.
Exhibiting: Welding literature.
In attendance: G. H. Mackenzie, president; F. L. Spangler, editor; L. C. Monroe, advertising manager; T. E. Depew, eastern manager; and J. C. Holcombe.

Wesley Steel Treating Co., Milwaukee, Wis.—Booth K-18.
Exhibiting (in operation): An activated pictorial story of our plant and its operations. Large colored photographs will be used, mounted on a moving wheel and illuminated in turn by a shadow box behind the wheel. A giant human figure in the foreground will be synchronized with the wheel so that it will point to each photograph as it moves in front of the shadow box.
In attendance: Arthur H. Nuesse, secretary; Roy M. Spindler, assistant secretary; Donald A. Petrie, sales department; and Mark K. Pinkerman, advertising manager.

Western Foundry Co., Chicago.—Booth M-24-A.

Westinghouse Electric & Mfg. Co. East Pittsburgh, Pa.—Booth C-16.
Exhibiting: New Westinghouse 500-amp. transformer type a.c. welder with a welding range from 100 to 500 amps. This machine operates at high efficiency and is equipped with automatic control which cuts the machine off the line when the operator stops work. It is brought back on the line by a momentary contact made by a switch in the holder. This transformer type single operated welder meets the need for relatively high current values for speedy production work. Also new Westinghouse 30-150 amp. a.c. welder. It is of the transformer type with high efficiency and is completely enclosed. It is available for primary voltages of 110/220 or 220/240. The machine weighs 230 lb. and is recommended for production work and for use in repair shops. Also on display is a 300 amp. flexarc d.c. welder with a.c. or d.c. drives, together with a display of phos-copper welding alloys with especial applications to refrigerator condensers, cooling coils, evaporators and piping; plumbing, radiators, cooling coils, water piping, water heaters, copper boilers; electrical bus bars, terminal connectors and damper windings.
In attendance: W. W. Reddie, sales dept.

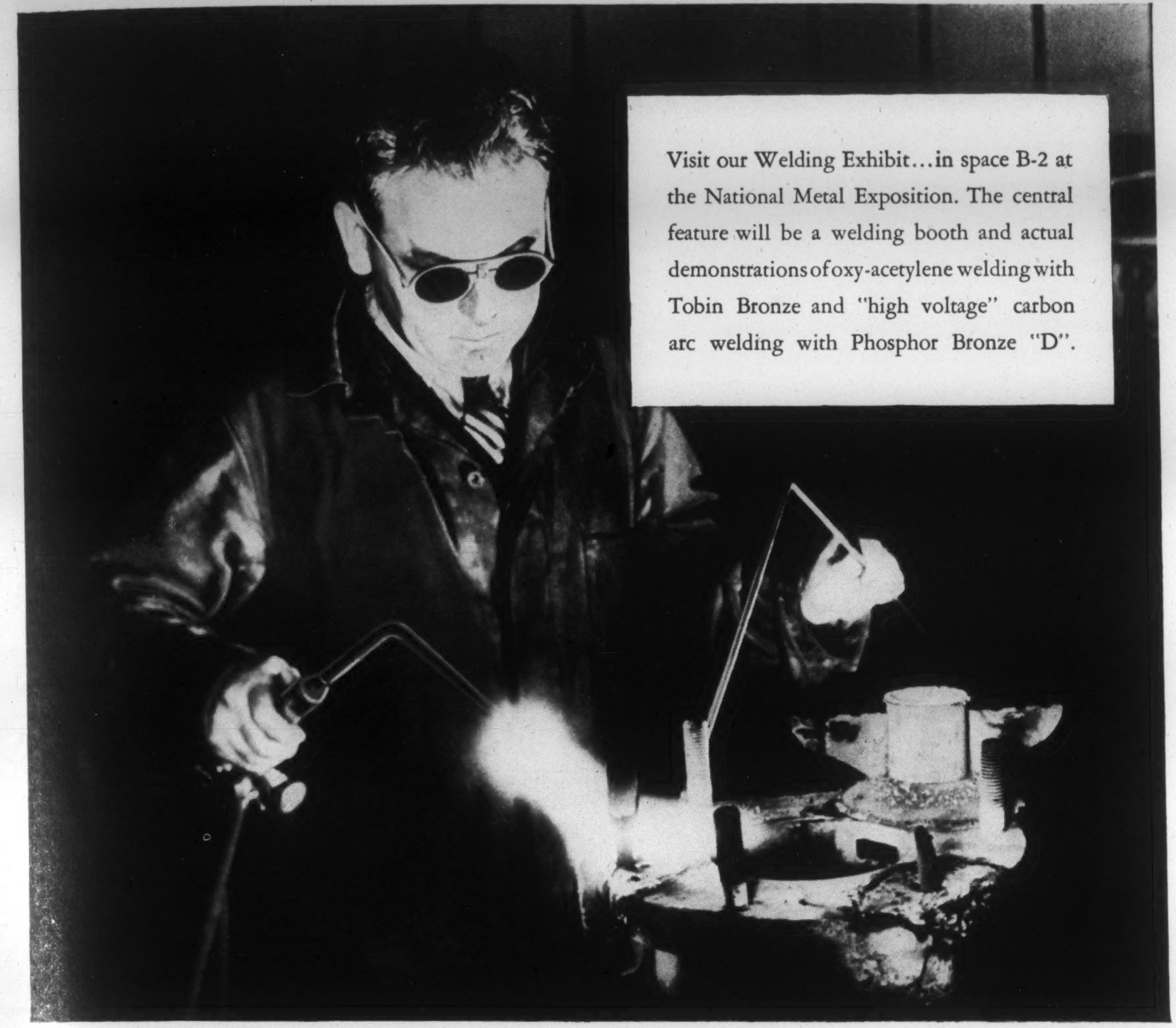
Wheelock, Lovejoy & Co., Inc., Cambridge, Mass.—Booth E-27.
Exhibiting: A display of unusual machine tool parts manufactured from "Hy-Ten," "Economo," and S.A.E. alloy machinery steels.
In attendance: A. Oram Fulton, president and treasurer; Frederick H. Lovejoy, vice-president; S. W. Parker, Chicago district manager; A. Reed Townsend, Chicago territory; J. S. Dreher and I. G. Stone, Chicago territory sales engineers; E. C. Bartlett, Cleveland district manager; and C. R. Jenks, resident manager Detroit territory.

Wickwire Spencer Steel Co., New York.—Booth C-31.
Exhibiting: "Wissco" wires and springs and formed wires especially adapted to the requirements of the automotive and its allied industries. These will include stainless steel, black oil tempered valve spring steel, music spring wire, shaped wires, machinery spring, book binder, brush, "Wissclad" music and rope wires; also springs and formed wires.

"Wissco" high and low temperature metal conveyor belts, including the new patented balanced spiral construction, as well as the patented conventional spiral design, will be displayed, together with engineering data developed through extensive research showing the performance of these "Wissco" belts under extreme conditions.

Special laboratory equipment in operation will illustrate complete testing facilities.

Wickwire Spencer wire rope, perforated metals, wire cloth, card clothing, and other products embracing the general line of the company will also shown.
In attendance: T. H. McSheehy, mid-western district sales manager; A. G. Bussmann wire and springs sales manager; J. R. Worsfold, sales manager mechanical specialties; B. L. McCarthy, metallurgist; R. C. Jordan, sales engineer; D. C. Evans, C. T. Toohill, wire sales division; R. W. Jones, conveyor belt sales division; L. J. Renner, H. D. Rollo, wire rope sales division; K. A. Zollner, advertising manager.



Visit our Welding Exhibit...in space B-2 at the National Metal Exposition. The central feature will be a welding booth and actual demonstrations of oxy-acetylene welding with Tobin Bronze and "high voltage" carbon arc welding with Phosphor Bronze "D".

This welder can't afford to take a chance on the quality of his rods . . . *Can You?*

MORE than a century of metallurgical experience accounts for the uniform composition and unvarying high quality of Anaconda Welding Rods.

Thousands of foremen, welders and helpers prefer them to all other brands. They help good workmen do good work.

There are seventeen different Anaconda Welding Rods . . . a suitable one for every gas or electric bronze-welding purpose. Available through leading distributors. Usually shipped in bulk, but also obtainable in clearly labeled 10-lb. packages. Our new publication B-13, mailed on request.

3550

MELTING POINTS OF ANACONDA WELDING RODS

Material	Approximate Melting Point—Degrees	
	Cent.	Fahr.
Tobin Bronze*	885	1625
Manganese Bronze	870	1598
Brazing Metal	930	1706
Economy Bronze*	885	1625
Everdur*	1019	1866
Anaconda 520	885	1625
Phosphor Bronze A	1050	1922
Phosphor Bronze E	1070	1958
Phosphor Bronze D	1000	1832
Phosphor Bronze C	1025	1877
Silicon Copper	1083	1981
Deoxidized Copper	1083	1981
Electrolytic Copper	1083	1981
Super Nickel	1225	2237
Nickel Silver	1055	1931
Ambrac*	1150	2102

*Trade-marks Reg. U. S. Pat. Off.

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ANACONDA WELDING RODS

Wilkens-Anderson Co., Chicago.—Booth M-2.

Exhibiting (in operation): Metallurgical sample preparation equipment such as, "Waco" Bakelite Press, "Waco" Bench grinders, "Waco" fine polishing machines; microscopes of latest construction made by Carl Zeiss, with particular attention to the recent developments of polarized light and darkfield applied to metal analysis; metallographic microscopes of Bausch & Lomb and Leitz manufacture; small shop microscopes; inspection and measuring microscopes and photo-micro and macrographic equipment; latest type Ainsworth analytical balances; high temperature combustion train; new metallurgical laboratory equipment.

In attendance: F. A. Anderson, vice-president; W. C. Burfischer technical engineer; and A. I. Buehler, optical department.

The Youngstown Sheet and Tube Co., Youngstown, Ohio. —Booths 824 and 826.

Exhibiting (in operation): A scale model of its new 79 in. continuous hot mill, an exact replica of the mill which was placed in operation, March 12, 1935. In order to illustrate the exact operation of this mill, a slab of lead is used and is reduced in thickness in the same manner in which the steel slab is reduced under actual operations. The background of the booth consists of a series of illuminated transparencies illustrating in natural color, various operations incident to the manufacture of steel. The background will be 40 ft. in length. The model for which the background is a stage setting, is possibly 26 ft. long. Included will be a display of this company's newly introduced high tensile, high corrosion resistance and high abrasion resistance steel,—"Yoloy." The company's alloy steel will also be exhibited.

In attendance: W. E. Watson, C. H. Longfield, M. S. Curtis, William McKenzie, Arthur Purnell A. N. Vogt, L. D. Seymour, W. H. Texter.

Ziv Steel & Wire Co., Chicago.—Booth K-14.

Exhibiting: Tools and dies.

In attendance: G. F. Ziv, president; F. A. Lawler, vice-president; A. F. Brunck, R. J. Foley, E. J. LaCroix, and H. Hardwicke.

Controlled Atmospheres in Steel Treating

IN the issue of METALS & ALLOYS for October there is published the third portion of Dr. H. W. Gillett's correlated abstract on "Controlled Atmospheres in Steel Treating." In the original announcement of this important article it was stated that it would be published in three installments. Since then, because of certain problems in publishing, it has been found necessary to print this abstract in four installments. Therefore the last portion will be found in the November issue.

This correlated abstract is a presentation of the status of the controlled atmosphere developments to date as applied to the heat treatment of steel. The first portion, or Part I, is largely introductory, while Part II dealt with the "Cost and Action of Different Usable Gases." Part III discussed "Furnaces in Which to Apply Controlled Atmospheres" and Part IV is entitled "Correlation of Experiments and Experiences."

The four parts are profusely illustrated with furnaces and equipment for producing gases.

Reprints of the entire abstract will be available at a reasonable cost. Orders should be placed early.

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CONSECUTIVELY

General Alloys Company has been the largest exhibitor in its line at the National Metal Shows . . . .

During this period we have shown a far greater variety of castings than all of our competitors combined, believing that such an exhibit is a contribution to science and industry alike.

Our exhibit at the Chicago Show will be larger than ever — come see it!

Surely, the outstanding leadership of this Company in engineering metallurgy and foundry practice entitles us to your enquiries.

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covering the period 1932-1934 inclusive, is now ready.

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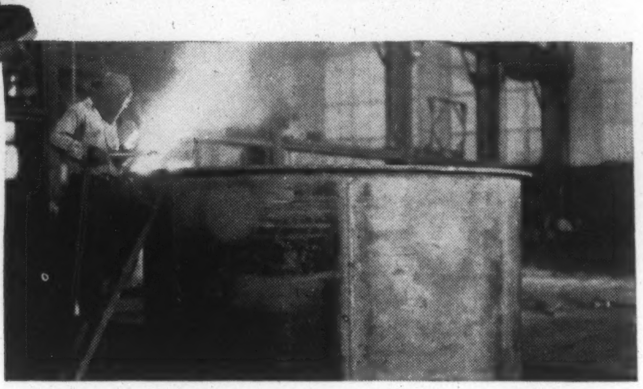
PREVIEW OF SEVENTEENTH NATIONAL METAL EXPOSITION

Why HERCULOY

U. S. PATENTS NO. 1,868,679 AND 2,002,460

GOT A REPEAT CALL

Herculoy plates 128½" in diameter—weight 7,600 lbs., for special tank described below.



One of America's leading chemical concerns have in their processing equipment a large recovery tank containing strong acids and tar compounds. Two years ago, when they installed this tank, the tank-shell was constructed from 5,000 pounds of welded sheet Herculoy.* For the head and bottom, it was believed that a rustable metal—copper-lined—would be satisfactory, so this was used.

However, in a short time trouble developed in the head plate. The potent acids worked behind the copper-lining and ate into the rustable metal. Replacement became necessary.

The Herculoy shell had resisted the corrosion perfectly, therefore head and bottom sections made of Herculoy were ordered. These pieces (shown as they were shipped) weigh 7,600 pounds; they are 128½ inches in diameter. The plates were rolled, dished and flanged by Worth Steel Co., Claymont, Del., and then shipped to the Ross Heater and Manufacturing Co. of Buffalo, who welded on the nozzles.

Once again Herculoy has proved its value in the handling of tough industrial assignments. Herculoy has been successfully applied for special jobs in the oil, chemical, sugar, paper, electrical, mining, and plumbing industries . . . and in municipal water and sewage plants.

Let our Technical Advisory Service cooperate with you on the use of this modern high-strength corrosion-resistant alloy in *your* industry. Address our Executive Offices.

*Herculoy is Revere's patented high-strength silicon-bronze alloy. It is as strong as low and medium carbon steel, and has a corrosion-resistance similar to that of pure copper. It is unusually ductile, has low electrical and thermal conductivity, is non-magnetic, readily welded, and easily drawn or formed.

Herculoy is available in hot rolled, cold rolled, or cold rolled and annealed sheets and plates, rolls and strips; hot rolled and cold drawn rods and shafting; tubes; die-pressed and hammered forgings; ingots for sand castings; and welding rod.

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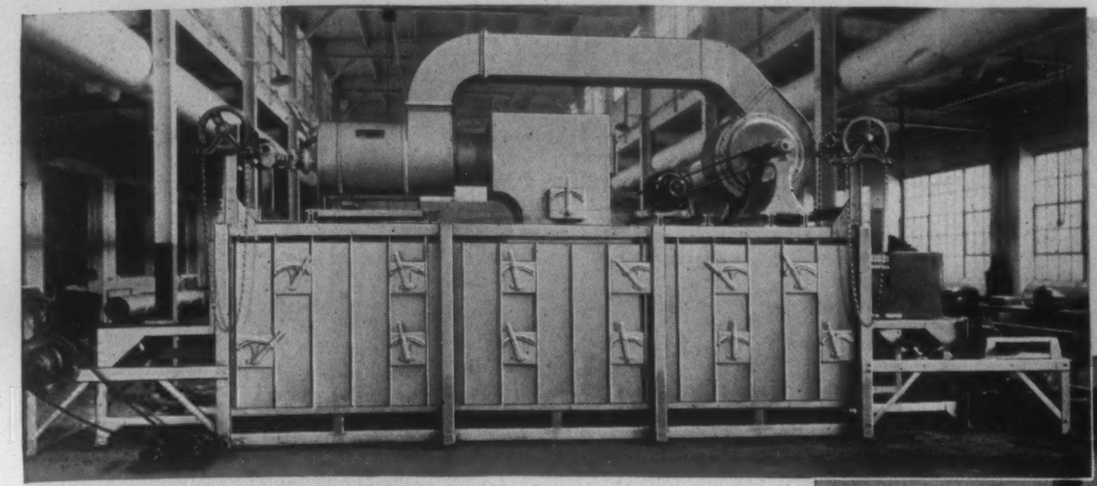
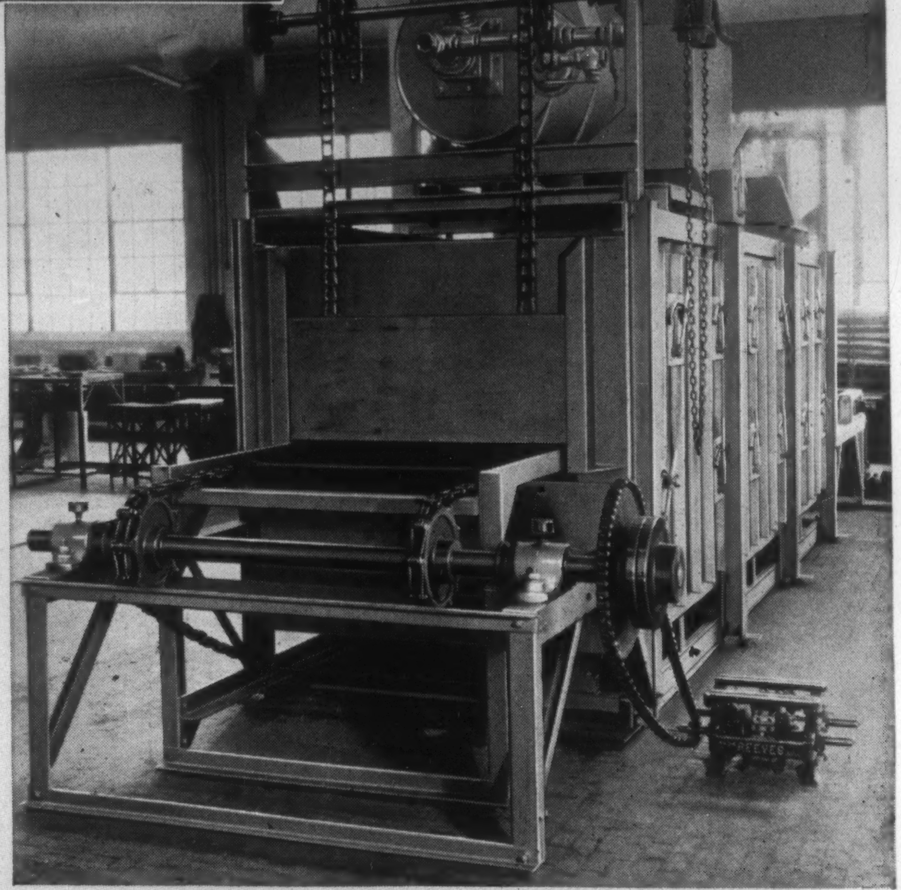


The view at the left shows location of Standard Air Heater and fan which circulates the heated air through the furnace. The single burner on the air heater (shown below) supplies sufficient air to heat the work to 700 F. in 30 minute cycles.



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Air, heated in a Standard Surface Combustion Air Heater (equipped with only one burner), is fan circulated through this S. C. developed Air Draw Furnace. This unique method of heating the work to be annealed has been developed, tested, and introduced to heat treaters by Surface Combustion. Several furnaces are already in operation.

In these furnaces annealing is being done more economically and so highly satisfactory that this annealing method has taken its place alongside numerous other important S. C. developments.

OPERATING DATA

Heats 2000 lbs.—3/4″ hex. brass rods (1.8 lbs. per ft.) to 700° when loaded at 20 lbs. per sq. ft. Also coils 16″ diameter x 8″ high weighing 90 lbs.
30 minutes required to heat to 700°.
Heated by convected air from a Standard S. C. Air Heater.
Heated air is fan circulated through the furnace with capacity of 4200 cu. ft. of air per minute.
Fuel Consumption: 375 cu. ft. per hour, 1000 B. T. U. gas.
Capacity: 500 cu. ft.

Rockwell Hardness	Before Annealing			—After Annealing		
	End	Middle	End	End	Middle	End
	70	75	69½	35	36	34½

You will want to know more about S. C. Convected Air Draw Furnaces. Let our Engineers give you details.

Surface Combustion Corporation

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Sales and Engineering Service in Principal Cities

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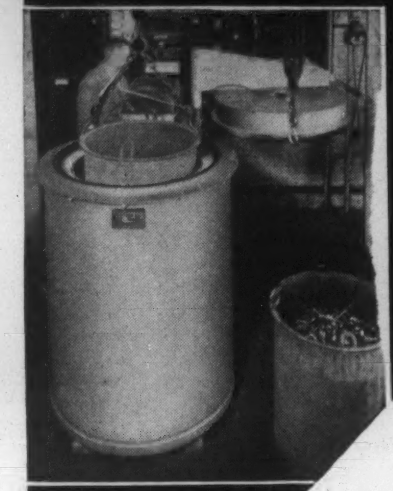
CYCLONE
Tempering Furnace



"Our Cyclone furnace is doing everything claimed for it." Russell Burdsall & Ward Bolt & Nut Co.

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"Die casting dies tempered in our Cyclone furnace are of uniform hardness regardless of the size of the furnace load or position in the furnace chamber." — The Hoover Co.

This Cyclone operating up to 1275° F. on high speed steel. Tests show uniformity throughout chamber better than ± 1° as measured with precision pyrometer and calibrated couples.

These furnaces operating 24 hours per day in our own plant. Experience in actual production operation aids in the design of efficient, trouble-free equipment.

- **RUGGEDNESS**
- **UNIFORMITY**
- **EFFICIENCY**
- **SPEED**
- **ACCURACY**

Leadership which steps out of the beaten path to offer entirely new principles of furnace construction and control.

Leadership which brings together in the same unit, laboratory accuracy, high production and amazing ruggedness.

Leadership which furnace users have been quick to recognize and furnace manufacturers have not hesitated to follow.

Leadership which is backed by years of experience in the use, as well as the construction, of heat treating equipment.

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Lindberg Engineering Co.
Division of Lindberg Steel Treating Company
218 UNION PARK COURT
CHICAGO, ILLINOIS

Presenting*

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TRADE MARK REG. U.S. PAT. OFF.

The new high speed steels

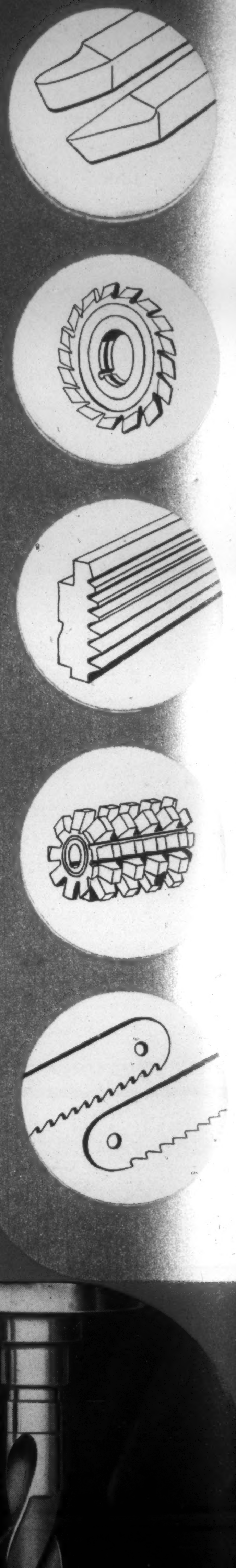
•THE THIN RED LINE

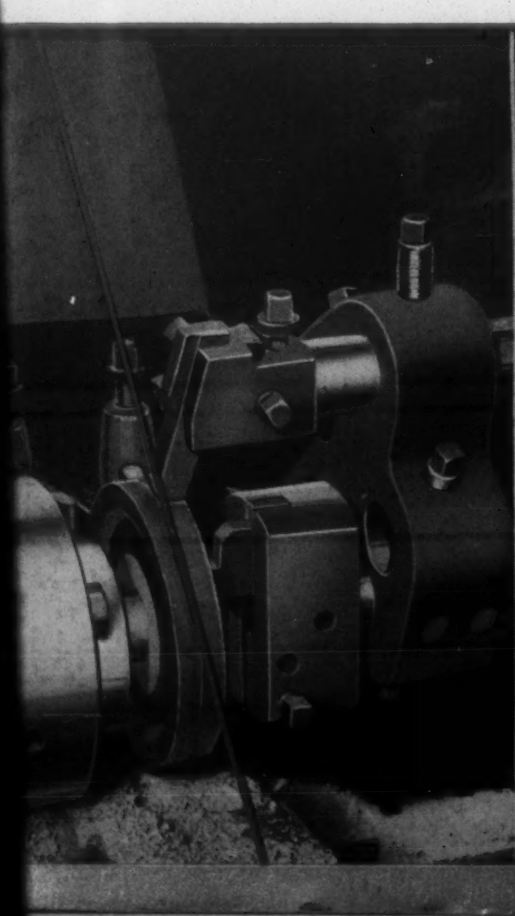
THE executive of any plant interested in reducing the cost of cutting-tools and cutting-operations will welcome the new molybdenum-tungsten high speed steels—MO-MAX. The thin red line that is the hot edge of a cutting-tool receives new support from the hot-hard, strong and tough MO-MAX.

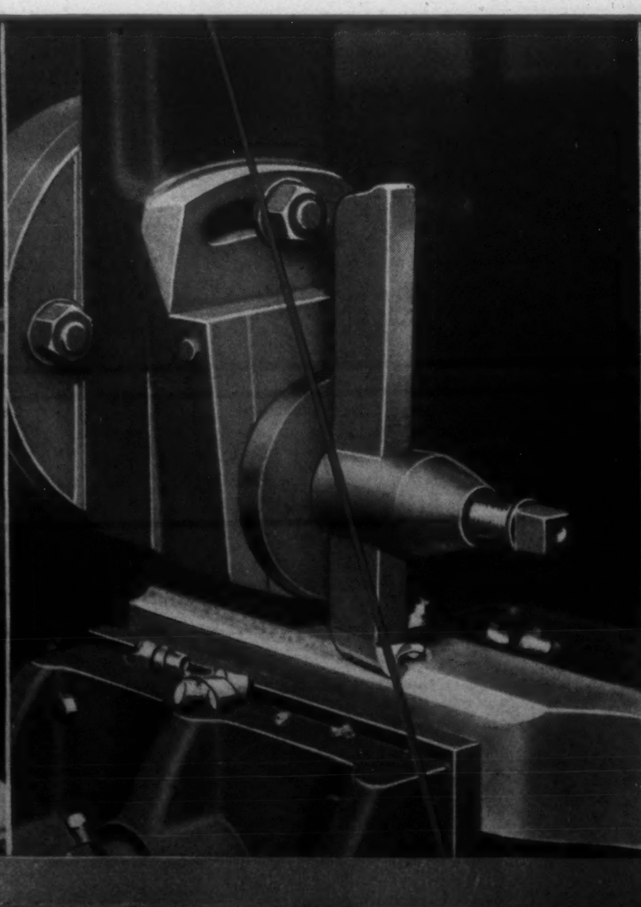
MO-MAX is a standard high speed steel for cutting-tools. Many tool manufacturers have adopted it for their most important products. Numerous tool users specify MO-MAX for their high speed tools.

In scores of plants, MO-MAX in the form of twist drills, reamers, cutters, hacksaws, lathe tools, tool bits and other cutting-tools is proving equal to, and often better than, other orthodox steels.

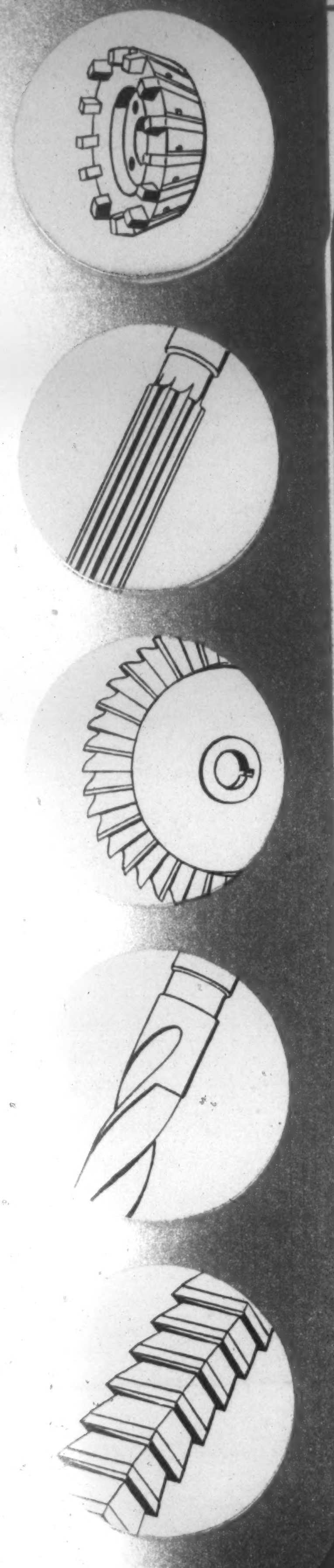
Born of the Great War, when the acute shortage of tungsten made it almost impossible to supply high speed cutting-tools of the then known steels in satisfactory quantity and quality, MO-MAX is the result of many years of painstaking research and experiment.







THE THIN RED LINE •

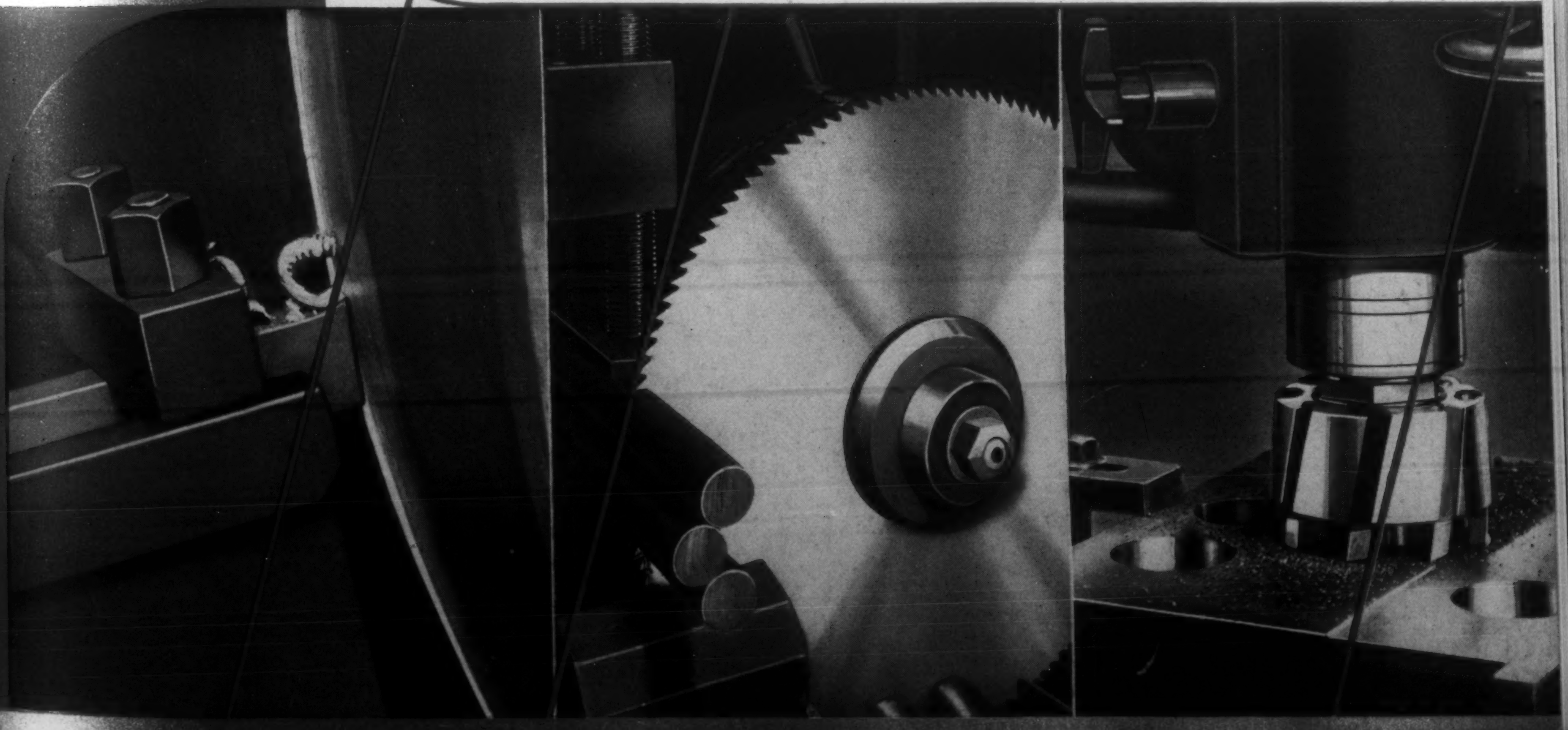


NOW, the results of tests, made under severe conditions of production service, demonstrate that MO-MAX has reached a commanding position in the field of high speed steels. It has shown a marked superiority where toughness and resistance to abrasion are essential.

MO-MAX, in the annealed condition, machines more readily with consequent savings in machining costs. Forging and hardening operations are carried on at temperatures about 150° F lower than required for conventional high speed steels. In addition to the savings due to lower cost in the tool room, MO-MAX is economical because it weighs about 8% less than other high speed steels commonly used.

MO-MAX is independent of foreign sources of tungsten. The United States has ample deposits of molybdenum—the chief alloying element—and American mines can supply the small amount of tungsten needed. Tungsten, therefore, ceases to be a "strategic material" and MO-MAX users are assured a more stable price and supply.

MO-MAX deserves the same careful study, handling and application as did the high speed tool steels that preceded it. For more detailed information about MO-MAX consult your usual sources of supply.



MO-MAX*

TRADE MARK REG. U.S. PAT. OFF.

APPLICATION—All high speed cutting-tools, punches, dies, wear and heat resisting parts.

APPROXIMATE COMPOSITION

C	.60 — .85	Mo	7.75 — 9.25
W	1.25 — 2.00	Cr	3.50 — 4.00
V	.90 — 1.50		

The lower carbons are used for tools requiring great toughness. The higher carbons are used for tools requiring great hardness and especially great red-hardness. The carbon content of MO-MAX is in general about 0.10% higher than for comparable grades of 18-4-1 high speed steel.

WEIGHT—Density about 7.95—approximately 8% less than 18-4-1 high speed steel.

MACHINING—MO-MAX is easy to machine and grind. Its hardness after annealing is slightly less than that of most high speed steels.

HOT WORKING AND HEAT TREATMENT—Typical working temperatures are:

Forging 1900°-2000° F (MO-MAX is workable down to 1700° F)

Annealing 1500°-1550° F

Hardening 2175°-2250° F to be varied according to the carbon content and kind of tool.

Tempering about 1050° F.

HARDNESS—Rockwell hardnesses in excess of C 65 are easily obtainable.

TOUGHNESS—As tough or tougher than other well known high speed steels.

LIFE—Total life and life between grinds is at least equal to that of high speed steels now in general use.

* MO-MAX is a proprietary name owned and controlled by The Cleveland Twist Drill Company and its only licensed use by others is on steel made and sold by licensees under Patent Number 1,937,334.

5162

The new high speed steels

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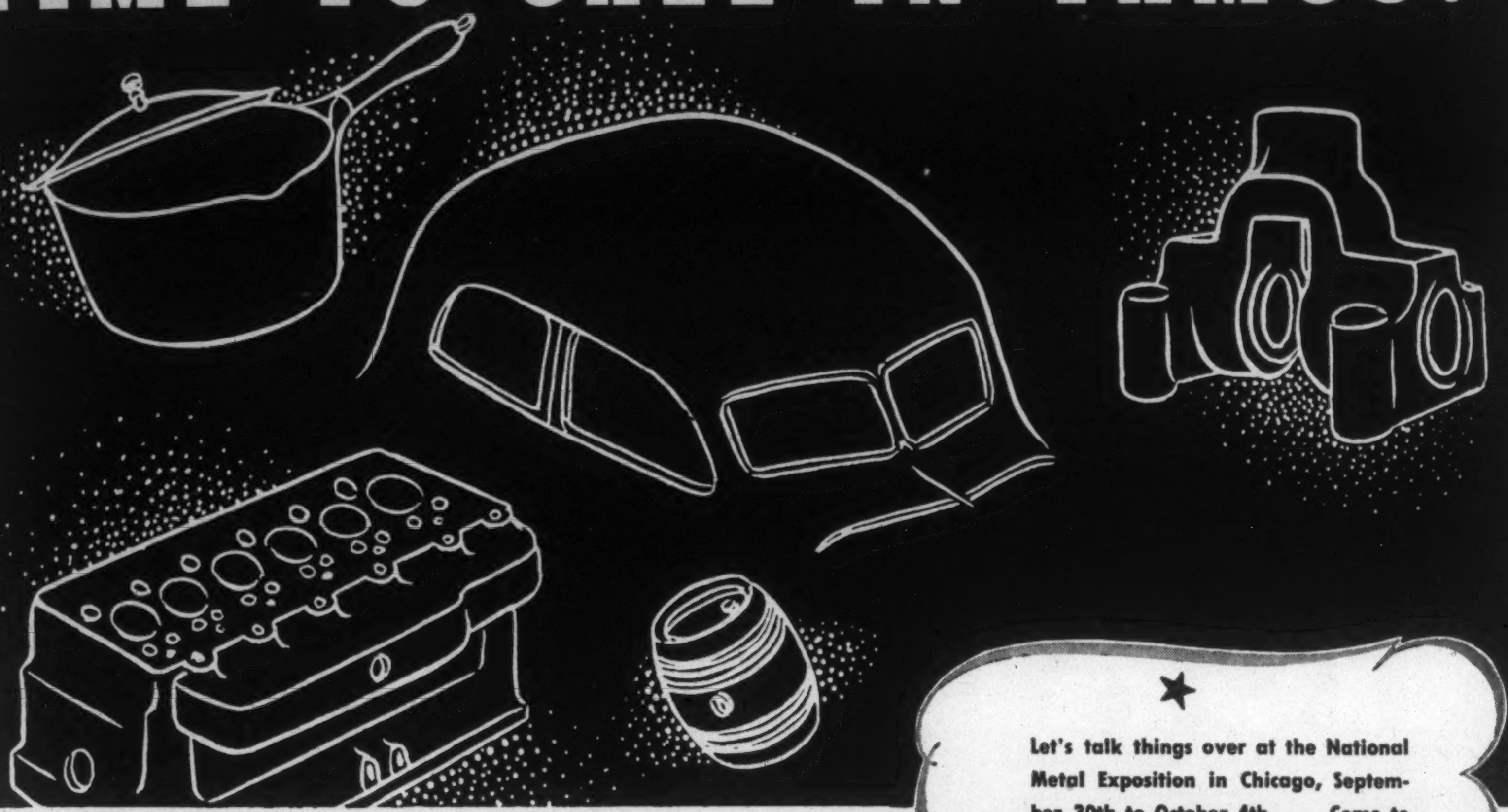

★

Let's talk things over at the National Metal Exposition in Chicago, September 30th to October 4th. . . . Come to Booth D-35. TAM Engineers will gladly give you as much time as you desire.

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METALLURGICAL ALLOYS

TAM Metallurgical Alloys stand for quality—the kind of quality that extends right down to the grain structure of the metal and renders it more ably suited to the job in hand. Thru enlightened combining of TAM Titanium, Zirconium, Molybdenum and other alloys with ferrous, as well as non-ferrous metals, marked improvements in physical properties are being achieved which heretofore have defied metallurgical effort. ● This *quality improving* faculty of TAM Metallurgical Alloys is not, moreover, limited to any one class of metals. Rolled, cast and forged steels, cast iron, effervescing and killed steels, tire and rail steels, stainless and similar steels, aluminum and copper alloys, and many other non-ferrous alloys—all are today being made better because of TAM alloy additions. ● Let TAM Research and a practical TAM Engineer assist in your constant search for improved quality in the particular ferrous or non-ferrous metals to which your plant is devoted. No obligation. Simply write, stating TAM applications of interest to you.

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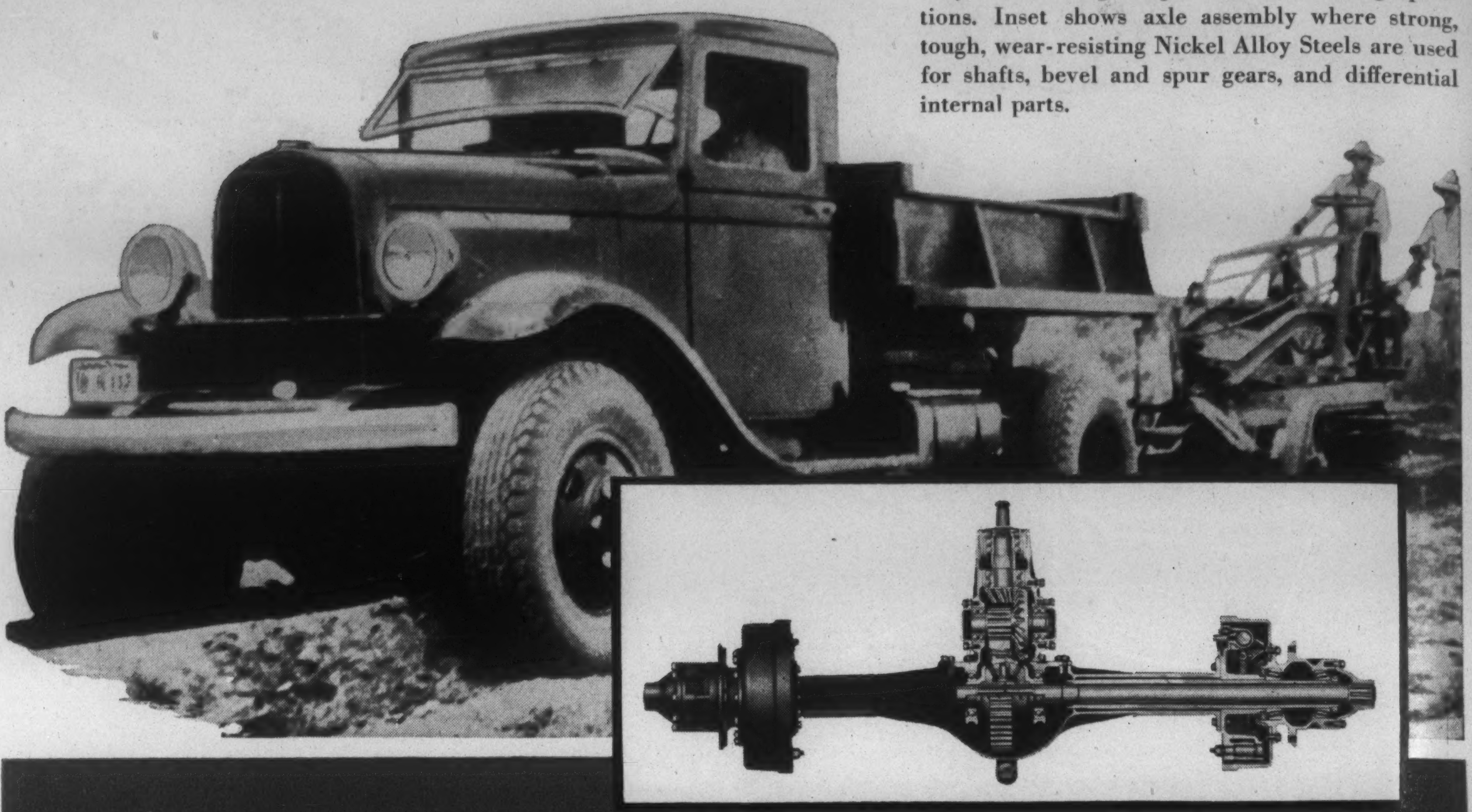
Truck turns tractor. Marmon-Herrington heavy duty unit hauling scraper in road building operations. Inset shows axle assembly where strong, tough, wear-resisting Nickel Alloy Steels are used for shafts, bevel and spur gears, and differential internal parts.



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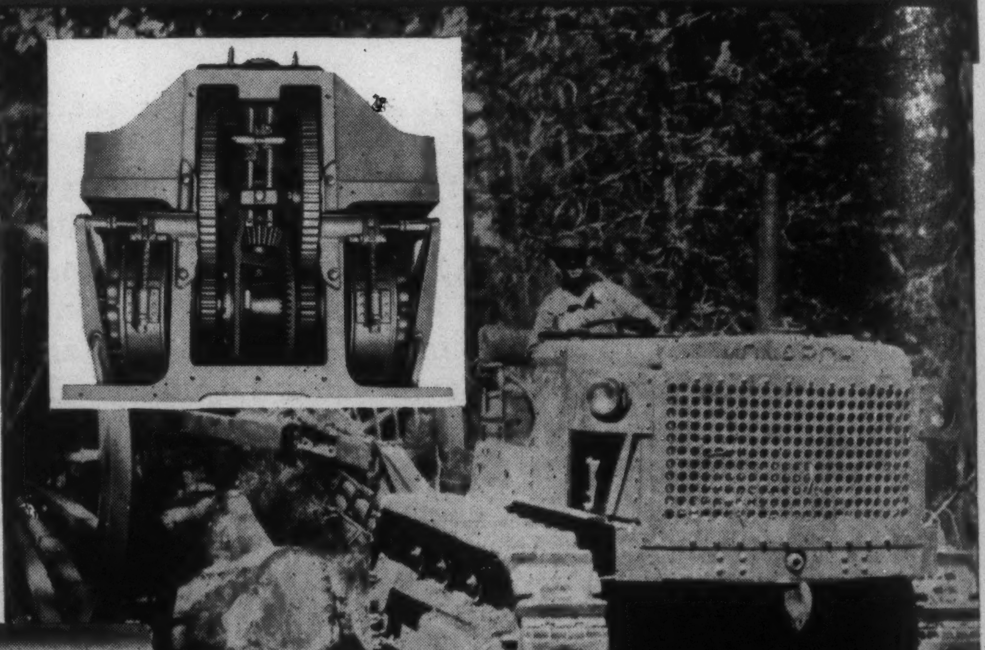

Tough as a tank, this timber towboat. An Allis Chalmers Monarch "75" logging in Oregon. Inset shows transmission assembly. All gears of Nickel Alloy Steels—selected for this punishing service because of superior toughness and high resistance to stresses and wear.

FREE! Send for our handy celluloid vest pocket size "Hardness Conversion Table." Quickly gives approximate relation between Brinell, Rockwell and Shore hardness values and corresponding strengths of Nickel Alloy Steels. Address Dept. J-4.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

metals and alloys

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PRODUCTION FABRICATION
TREATMENT APPLICATION

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HIGHLIGHTS

Written by the Abstract Section Editors and the Editorial Staff

DO YOU want to know what metallurgical engineers are saying, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Cast Steel Contraction

Briggs and Gezelius (page MA 392 L 8) show the relationship between analysis and contraction of carbon cast steels. The effect of carbon is particularly important.—C.H.H.

More About Furnace Atmospheres

Continued interest and research regarding the effects of furnace atmospheres on the surface of heat treated products is indicated by the abstracts of papers by Lake (page MA 395 L 2), Grangette (page MA 395 R 3), Oliver (page MA 396 L 1) and Electric Auto-Lite Co. (page MA 396 L 10).—O.E.H.

Oxygen in Metallurgy

Miller (page MA 396 R 2) and Nagel (page MA 396 R 4) both discuss oxygen instead of air for metallurgical use.—H.W.G.

German Cupolas Have Rammed-In Linings

Borsch (page MA 396 R 5) says that 70 per cent of the German cupolas have rammed-in linings.—H.W.G.

Combustion Research

Further contributions by the American Gas Association to the important and neglected field of combustion research are described by Mattocks (page MA 397 R 2).—M.H.M.

Streamlined Trains and Welding

Welding in its various forms is utilized to a remarkable extent in high-speed train construction. While reduced weight is of great importance, particularly in securing the required acceleration, nevertheless, primary consideration must be given to structural strength and rigidity for protection of passengers and crew, riding comfort, and reduction in operating and maintenance costs. As with automobile bodies, these requirements are best met by welded construction. Even such parts as engine bed plates and end sills for connecting the cars are usually of welded-steel. The extent to which welding is employed is well illustrated by the bronze overlays on rocker rings on motors for the new Pennsylvania Railroad electric locomotives (page MA 402 L 2).—E.V.D.

High Pressure Water-Spray for Scale Removal

Pronounced success is reported for a water-spray method for the removal of oxide scale from steel, the surface of which must be left with a high finish. This is not so surprising, however, when one considers the high erosive effect of very small drops of water moving at a velocity of over 350 ft. per sec. (page MA 404 R1).—H.S.R.

Improvement in Tin Plating

As is well known from elementary chemistry, tin can exist in solution in two forms, bivalent or tetravalent. According to recent investigations (page MA 404 R 8) success in tin electroplating from alkaline baths is dependent upon this fact. For the production of uniform, dense, adherent tin coatings the solution must be free from tin in the bivalent state.—H.S.R.

Flaky Steel Due to Hydrogen

Esser and co-workers (page MA 407 L 2) produce some rather definite evidence that flaky steel is ascribable to hydrogen.—H.W.G.

Brittleness Due to Size?

Two articles in *Engineering* (page MA 407 L 8 and page MA 407 L 10) discuss whether very large notched castings and forgings may not be brittle simply due to size even though a small specimen cut from the large piece would be tough.—H.W.G.

A Problem in Higher Mathematics

Schlechtweg (page MA 408 L 2) claims to have a method of plotting tensile test results on cast iron so that the true modulus of elasticity can be shown. As this involves "univariants of the stress tensor" some higher mathematician than we are would be required to pass on the correctness of the method.—H.W.G.

Does Size of Specimen Affect Fatigue Limit?

Mailänder and Bauersfeld (page MA 408 L 7) report lowered endurance limit under reversed torsion for large specimens than for smaller specimens of the same metal. In a recent discussion of fatigue of metals it was reported that tests had shown that, using large specimens, the lower strength steels showed about as high stress-concentration at notches as did high strength alloy steels, a sharp contrast with the results reported by several experimenters from tests of small specimens. Looks as if the testing engineer would have to figure on getting large repeated-stress testing machines, -hydraulic pulsators, electro-magnetic machines, centrifugal force machines, or what have you Mr. Testing Machine manufacturer.—H.F.M.

More Penetrating than Gamma-rays

Myasnikov (page MA 407 L 3) reports that the internal structure of metal pieces more than a meter in thickness can be studied by a supersonic beam. The specimen is smeared with oil and the ripples in the oil tell the story.—C.S.B.

More About the Alpha Bronzes

The alpha bronzes have been studied again by two Russians (page MA 409 L 2), two Japs, (page MA 409 L 5) and two Englishmen (page MA 409 L 6). The solubility limit of the alpha field found varies in each of the three investigations, as it has in many previous investigations. Some of the most common alloys are the most stubborn about revealing all their intricacies.—H.W.G.

Who Wants Gray Tin?

Gray tin can now be made to form 7000 times faster than before, say Cohen and van Lieshout (page MA 409 L 8), but who wants gray tin?—H.W.G.

Carbide Precipitation Accelerated

Chevenard and Wache (page MA 409 L 9) report that carbide precipitation in a high nickel-chromium steel is accelerated by subjecting the metal to alternating stress. Perhaps the next apparatus for precipitation hardening will be the cocktail shaker.—J.S.M.

A Claim Rather Incredible

If the abstractor didn't add on a cypher, Adloff (page MA 414 R 2) claims that a 4 to 6 Cr, 1 W steel has 100 times the creep resistance of carbon steel. A claim for 10 times would have to be amplified by giving the conditions of comparison; that for 100 is incredible.—H.W.G.

Long-Time vs Short-Time High Temperature Tests

It is a relief to have Ruttmann and Mailänder (page MA 414 R 3) state that long time high temperature properties cannot be determined by short time tests. If German workers come to realize that, in this connection, 100 hr. is a short, and not a long time, we may be spared some of the "24th to 36th hr." type of testing that now clutters up the German literature with meaningless data.—H.W.G.

Metallic Coatings

For an excellent summary of the general characteristics of coatings of Zn, Al, Sn, Pb, Cd and Ni see Robson and Lewis (page MA 415 L 2).—V.V.K.

Metals vs Food Products

The processing of good food in the course of canning requires almost completely resistant materials. LaQue (page MA 415 L 5 and L 6) gives the results of actual operating conditions on a number of different metals.—V.V.K.

Low Cost—All Metal—Ship Construction

Bethlehem Shipbuilding Corp. announces the development of an all metal stateroom for ships (page MA 420 L 2) employing essentially ferrous alloys, which can be built within the weight allowance permitted in modern ship design at a non-prohibitive cost.—G.L.C.

ROLLED NICKEL

Strong • Corrosion Resistant • Easily Fabricated

Composition

Rolled nickel is a strong, tough metal that has excellent resistance to corrosion against many chemicals. Its mechanical properties and corrosion resistance are inherent; they are not developed by heat treatment.

The metal is produced in a modern rolling mill fully equipped with facilities for controlling the quality and uniformity. The following analysis is typical.

Nickel and Cobalt	99.4 %	Silicon	0.10 %
Copper	0.10%	Carbon	0.10 %
Iron	0.15%	Sulfur	0.005%
Manganese	0.15%		

Special nickel-manganese alloys, identified as D-Nickel, E-Nickel, etc., are supplied for special purposes, such as spark plug wire and bolts for anchoring the refractory linings of fire boxes on board ship.

Availability and Fabrication

Nickel is available in all usual mill forms and as forgings, rivets, bolts, etc. and castings. The metal fabricates readily and may be joined by all regular methods. Bulletins on designing equipment and instructions for fabricating are available on request. In addition, a fabricating and welding service is maintained.

Welding: Nickel is welded by all regular methods and welds do not require heat treatment. Gas and electric welding wire are distributed through the same channels as the metal.

Forging: Nickel forges readily at 1600–2300° F. Proper heating is important. Avoid exposing the hot metal to sulfurous heating atmospheres or other sources of sulfur. The heating atmosphere in contact with the metal should be reducing, i.e., 2–5% excess CO.

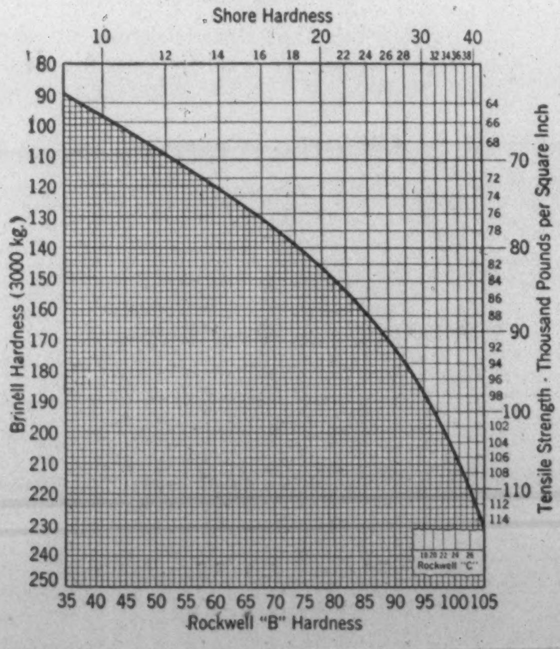
Annealing: Clean off any lubricant, paint marks, etc., before annealing. Softening begins at 1200° F. and proceeds rapidly above 1500° F. Prolonged heating above 1500° F. develops large grain size, which is not desirable. See notes on heating under forging.

Machining: Use slower speeds and lighter cuts and employ tools of tough high speed steel ground with sharper angles. Sulfurized mineral oil is used abundantly as a lubricant for boring, etc., and is preferred for all work, though water soluble oils suffice for lathe work.

Drawing and Spinning: Nickel draws like steel and practice is similar. Use harder dies and lubricants with high film strength, such as beef tallow or castor oil. Anneal after 35–40% reduction of diameter.

For difficult spinning jobs, a special carbon-free nickel sheet is available that spins almost as readily as copper. Special carbon-free nickel is annealed at approximately 100° F. lower temperature.

Approximate Relations Between Brinell, Rockwell and Shore Hardness and the Tensile Strength of Nickel

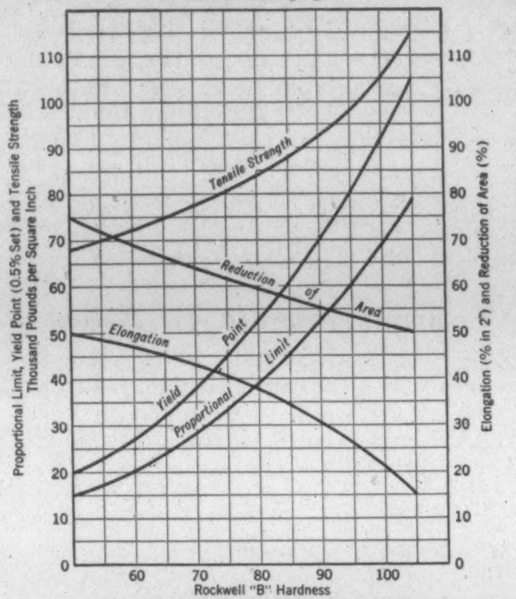


Conversions from one scale to another are made at the intercepts with the curve crossing the chart. For example, follow the horizontal line representing 170 Brinell hardness to its intersection with the conversion curve. From this point follow vertically downward for Rockwell B values (89), vertically upward for Shore values (26), and horizontally to the right for the tensile strength (91,000).

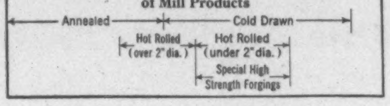
Mechanical Properties

Nickel is stronger and more ductile than structural steel for bridges, and it is exceedingly tough. The two charts below give its mechanical properties. When standard Izod specimens of nickel, hot rolled or annealed, are tested for toughness the test pieces remain unbroken.

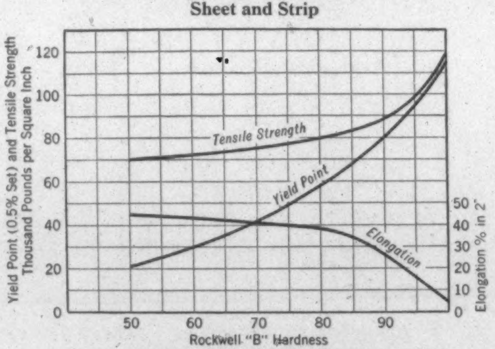
Average Properties of Nickel Rods and Forgings



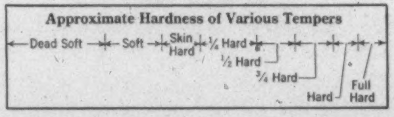
Yield Point and Tensile Strength Ranges of Mill Products


Annealed
Cold Drawn
Hot Rolled (over 2" dia.)
Hot Rolled (under 2" dia.)
Special High Strength Forgings

Average Properties of Nickel Sheet and Strip



Approximate Hardness of Various Tempers



Effect of Temperature on Properties

The tensile strength (short time tests) of nickel is approximately 21,000 lb. per sq. in. at 1100° F. and 9,000 lb. per sq. in. at 1800° F. Nickel is as strong at 1800° F. as pure iron at 1250° F.

Sub-normal temperatures do not impair the toughness of nickel. The yield point and elongation are 40–50% higher at 300° below zero Fahrenheit than at room temperature.

Physical Constants

Density	8.85
Specific Gravity, lbs. per cu. in.	0.319
Melting Point	1450° C. or 2640° F.
Specific Heat (20–400° C.) cal./gm./° C.	0.130
Coefficient of Expansion (25–100° C.)	0.000013
Thermal Conductivity (0–100° C.) cal./cm²/sec./° C./cm.	0.14
Electrical Resistivity	
Microhms per cm. cube at 20° C. or 68° F.	10.4
Ohms per circular mil-foot at 20° C. or 68° F.	62.6
Temperature Coefficient	0.0048 per ° C. or 0.0027 per ° F.
Elastic Modulus	30,000,000
Torsional Modulus	10,000,000

Magnetic Properties

Nickel is magnetic at temperatures below its transformation point, which is approximately 680° F. When the strength of field is 60 Gausses, the magnetic induction is approximately 5,500 Gausses. Permeability at low field strengths increases with temperature up to about 600° F.

Uses and Advantages

As nickel has both good mechanical properties and high corrosion resistance, it is useful in a wide variety of applications.

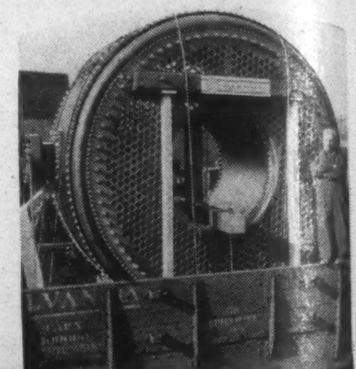
Its immunity to rusting, and its strength and freedom from distortion at elevated temperatures are among the important factors contributing to the general use of nickel in radio tubes. The carefully assembled metal parts are outgassed at temperatures as high as 1875° F. during the final manufacturing operations and must not warp in the process.

Though mechanical strength and ease of fabrication are essential for vacuum evaporators, it is the outstanding corrosion resistance of nickel against hot concentrated caustic soda that accounts for its extensive use in evaporators and related equipment used for the production of pure caustic soda. Of importance when concentrating caustic is the excellent resistance of nickel seamless drawn tubing against the abrasive action of crystals and corrosive action of salt.

Light colored phenol-formaldehyde resins, now available in pastel shades, are processed in nickel equipment and pure phenol required for their manufacture is shipped in tank cars of nickel-clad steel. Nickel is used because it does not affect the product, which is of high purity. For the same reason, nickel equipment is employed in manufacturing photographic gelatine required for sensitive emulsions.

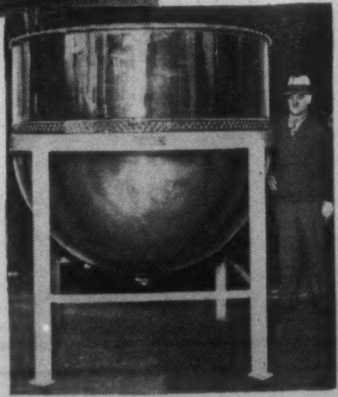
Its relatively high thermal conductivity gives nickel an advantage over other corrosion resisting metals when used in steam jacketed kettles and similar heating equipment made of heavy gauge material. Tests of full size equipment show that 250 gal. jacketed kettles of 0.172 ga. nickel boil water almost as fast as copper and nearly twice as fast as kettles made to the same specification but constructed of Cr-Ni-Fe alloy.

Write for further information about nickel for your particular purpose. Our engineers have accumulated much useful information about the corrosion resistance of metals under a wide variety of conditions. Corrosion testing devices have been developed that can be used conveniently for testing metals in operating equipment. Ask for details of this service.



One of many pure nickel steam chests that are in service in vacuum evaporators producing pure caustic soda for the rayon, soap and other industries.

Pure phenol is shipped in this tank car built from nickel-clad steel and equipped with heating coils of pure nickel.



500 gal. steam jacketed kettle fabricated from heavy gauge nickel sheet. Outer shell fastened with nickel rivets. All other joints welded.

Literature

Send for List B showing all technical bulletins and other literature on Monel Metal and rolled nickel. If interested also in nickel steels, nickel cast iron, nickel bronzes, etc., ask for List A as well.

Copies of this and similar pages are available in loose leaf form. Send for yours.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.

The Editorial Advisory Board

(Continued from the July, August and September Issues)

S. L. HOYT is director of metallurgical research, the A. O. Smith Corp., Milwaukee. He is a graduate of the school of mines of the University of Minnesota, class of 1909. From 1909 to 1911 he did graduate work at Columbia University and from 1911 to 1913 at the Charlottenburg Technical School, Berlin, Germany. For a dissertation on "The Copper-Rich Kalchoids" he was awarded a Ph.D. degree at Columbia in 1914. He founded the department of metallography of the Minnesota School of Mines in 1913 and was assistant and associate professor of metallography until June, 1919. During the war, Dr. Hoyt was in charge of field investigations of the use of ferroalloys in open-hearth and electric furnace practice for the U. S. Bureau of Mines and the National Research Council.

S. L. Hoyt

From June, 1919, to December, 1930, Dr. Hoyt was research metallurgist with the General Electric Co., 3 yrs. in the Incandescent Lamp Dept., Nela Park, Cleveland, and 8½ yrs. at the research laboratory, Schenectady, embracing lamp and steel problems, and the development of "Carboloy." From January, 1931, to the present time he has been in the research and engineering department of the A. O. Smith Corp. His present position dates from April, 1934. He is a member of the A. I. M. and M. E., the A. S. M. and the Institute of Metals.

J. B. JOHNSON is chief of the material branch at Wright Field of the Air Corps, Dayton, Ohio, which is part of the War Department.

Born in Olean, N. Y., Mr. Johnson attended Cornell University from which he was graduated in 1912 with a degree in mechanical engineering. He devoted six years to work in the motive power and mechanical engineering departments of the Pennsylvania Railroad and the New York Central Railroad. After this experience, he became connected with the war department of the Government. Previous to his present position in that department, he was active in the inspection and engineering departments. Here he was engaged in the development and in the testing of materials for airplanes and in investigating fabricating processes. This broad experience led up to his present position.

J. B. Johnson

Mr. Johnson is a member of the American Society for Testing Materials and active on its numerous committees. He is also a member of the American Society for Metals. He is the author of several technical papers dealing with the properties and inspection of materials which he has presented before technical societies and in the technical press. His book on "Aircraft Welding" is an authoritative treatise on this important subject.

JOHN JOHNSTON is director of research of the research laboratory of the United States Steel Corp., Kearny, N. J. Born in Perth, Scotland, he was educated at University College, Dundee, part of the University of St. Andrews, where he was graduated in 1903 with the degree of B.S. He was awarded a Carnegie scholarship in chemistry in 1903 and did research work (1903 to 1905) with Prof. James Walker in Dundee. Appointed in 1905 to the 1851 Exhibition Scholarship for 2 yrs., he worked with Prof. Abegg at the University of Breslau, Germany. From 1907 to 1908 he was research associate in the laboratory of physical chemistry at the Mass. Inst. of Tech., working with Prof. A. A. Noyes. His degree of D. Sc. was obtained in 1908 from St. Andrews University.

Dr. Johnston's activities since 1908 were briefly as follows: On the staff of the geophysical laboratory of the Carnegie Institute of Washington, 1908 to 1916; in charge of research department of Amer. Zinc, Lead & Smelting Co., St. Louis, 1916 to 1917; war gas investigations at Washington, 1917 to 1918; secretary, National Research Council and chairman, chemistry division, Washington, 1918 to 1919; Sterling Professor of Chemistry at Yale and chairman, department of chemistry, 1919 to 1927. His present position dates from 1927.

John Johnston

As a member of numerous scientific societies, Dr. Johnston is the author of some 60 papers, dealing mainly with physicochemical topics. He has been an assistant editor of Chemical Abstracts, a member of the editorial board of the Journal of the A.C.S. and editor of its series of Technical Monographs.

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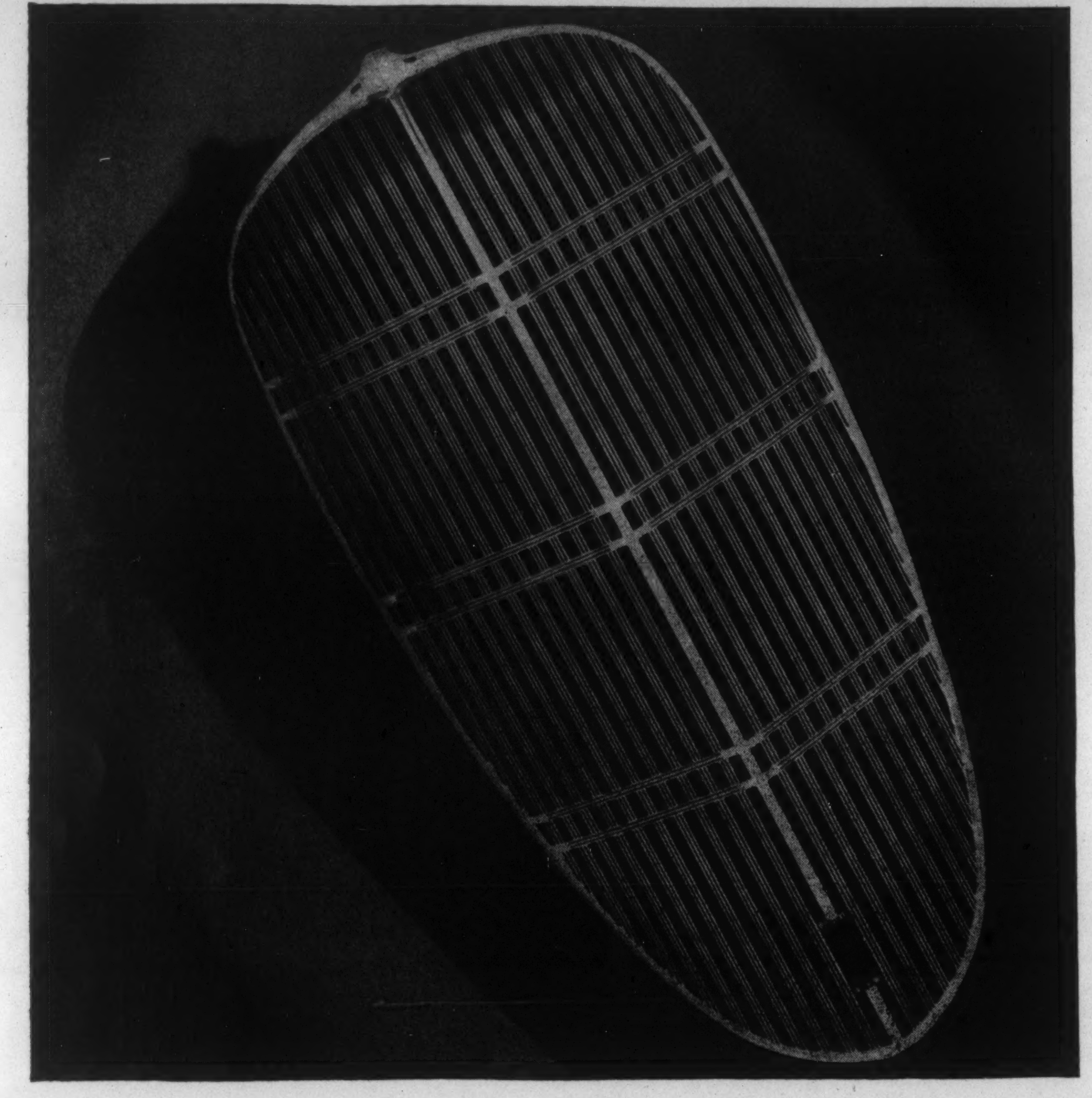
Most Die Castings are specified with
HORSE HEAD SPECIAL ZINC



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EDITORIAL COMMENT

High Temperature Chemistry

IF we admit that metallurgy is a branch of inorganic chemistry, (or if we wish to particularize, perhaps more often one of physical chemistry), it seems odd that chemical text books and chemical courses have not been generally revamped to pay more attention to metallurgy.

Herty's work on "The Physical Chemistry of Steel Making" has been distinctly labeled as such, yet how many chemical students are taught anything of that work? Similar omissions are found in respect to other high temperature chemical industries, for example, those dealing with fuels, refractories, enameling, and the like. Only the briefest of references are commonly made to the reactions that go on at very high temperatures. The chemist is brought up to think that anything that happens very much above the temperature of boiling water is someone else's business. Yet the very fact that the laws of physical chemistry at ordinary temperatures do not hold so rigidly, or at least are usually more difficult to express in formulae, ought to make him interested in establishing the limits of validity.

The difficulty is probably traceable in part to the poverty of the average educational institution. Experiments can be cheaply carried out when they involve merely a little glass blowing, a Bunsen burner and a thermometer, while the equipment for high temperature work would start with a few thousand dollars for a high-frequency furnace and a few thousand more for auxiliary equipment. Poverty is not the sole reason, however, for more than one institution that owns such equipment lets it be idle nearly all the time. The experiments that would be instructive are not all worked out and described in the laboratory manuals; the professor would have to do a bit of pioneering and devise them for himself.

If one asked the average chemical graduate, who had never been in industry, to name the first ten important chemical processes that pop into his head, on how many lists would any appear that could not be carried out in glassware? And if you asked the professor to name some research subjects for investigation, how many would think of such topics as the solubility of gases in, and their release from, molten metals; diffusion of elements in alloys at high temperatures; the cause of opacity in enamels; the corrosion of refractories by slag; or the mechanism of precipitation hardening?

Almost the only approach to such subjects that even the post-graduate chemist gets is the fact that these topics are included in the field covered by Chemical Abstracts and, hence, he may have a faint idea that somebody considers them to be touching on, and appertaining to, chemistry.

Yet a large proportion of chemical graduates are absorbed by the high-temperature industries, and more could be if the chemists were better trained in the fundamentals that are of importance in those industries and had more facility in the type of experimental work required in them. That so many chemists do such good work in these industries is a tribute to their native common sense and ability to utilize the literature of the specialized industries, rather than to any training intentionally given to help them assimilate matters so foreign to their previous lines of thought.

We are not pleading for extremely specialized instruction, but rather for a broadening of the point of view so that the student will have some familiarity with high temperature operations and something of the same feeling of sureness with which he approaches a problem that can be worked out with beaker and test tube.—H. W. G.

Air Conditioning and the Metal Industry

FOR some time it has been realized that the air conditioning industry is rapidly expanding. Some definite measure of its growth is now available from the American Iron and Steel Institute. That authority states that more than 600,000 tons of steel have gone into air-conditioning equipment now in use in the United States, that approximately 28,000 tons were acquired in 1934, that this will be doubled in 1935 and that within the next ten years an estimated 450,000 tons will be annually required.

This industry is in its infancy. That it will grow to very large proportions is admitted. It started with the "weather-controlling" of theatres but it has spread already to office buildings, passenger trains and even individual homes. Its benefits are self-evident. One wonders why it was not developed earlier.

In equipment for air conditioning, metals in many forms and types are and will be required. These now include sheet steel, copper-bearing, painted or galvanized; alloy steels; special non-ferrous metals and alloys and others. The quantity of pipe and light shapes required is increasing and, as designs are altered, other forms as well as materials will come into the picture. There are, however, many problems to solve. Haste to build the equipment at as low a cost as possible has involved the use of materials which should not have been considered where corrosion and many other conditions have to be met. Conditions in various parts of the country also have given rise to complicated problems.

It is not difficult to visualize the extent to which metals and alloys of many types will be demanded and used. Here is a field which will offer opportunities for the ingenuity of the metallurgical engineer as well as a market for the metal producing and metal working industries. The growth of this industry will bear watching. One authority has said that, as in 1921 the automobile industry was a large factor in leading us out of the depression of that period, so the air-condi-

(Continued on page 272)

Uncertainties have always been a source of anxiety. When navigators had to trust to whims of sea and sky, risks were great. Human ingenuity has eliminated these variables.

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The Story of the Ford Cast Crankshaft

By EDWIN F. CONE

ANNOUNCEMENT ABOUT THREE YEARS ago of the successful production of a cast crankshaft for automobiles by the Ford Motor Co. created wide interest. The supplanting of a steel forging with a cast metal product was regarded as a radical departure. Some doubted the ultimate success of the venture. But Ford metallurgists and engineers have overcome all obstacles and today the production and use of cast crankshafts in the Ford V-8 engines are an established practice.

Several articles have been published describing the composition of the shafts and the foundry practice. The real story behind the development of the balancing of the elements in this rather unique product has never been told. The various problems which were encountered, the reasons for selecting certain alloying metals, the factors determining the quantities of each constituent, combine to make a report of intense interest to metallurgical engineers. METALS & ALLOYS is fortunate in being able to present this story.

Character of the Metal

The metal in the cast crankshaft has been given several unusual names. Some dub it cast alloy steel, others class it as partaking of the characteristics of steel, gray iron and malleable iron. It does not come under any of these headings, as products are usually classified. It is a "hybrid metal." High in carbon (1.35 to 1.60%) it contains as alloys copper, silicon, and chromium. By some it would be termed a high-carbon, copper, sil-chrome steel. The carbon may be compared to a certain extent to the temper carbon in malleable iron. It also, probably because of its form and distribution throughout the mass, provides some lubrication. The composition and heat treatment apparently render the metal immune to the fatigue factor which effectively lowers the life of a forged steel crankshaft. Whatever its real position among alloys, it is a unique and interesting product, never before used in just this form for any purpose.

Previous to the adoption of the new cast shaft, the Ford organization was using in its cars a forged and heat-treated steel shaft of the following approximate composition:

	Per Cent
Carbon	0.35 to 0.40
Maganese	0.70 to 0.90
Silicon	0.07 to 0.15
Phosphorus	0.03 max.
Sulphur	0.03 max.

This is a typical carbon steel for forging.

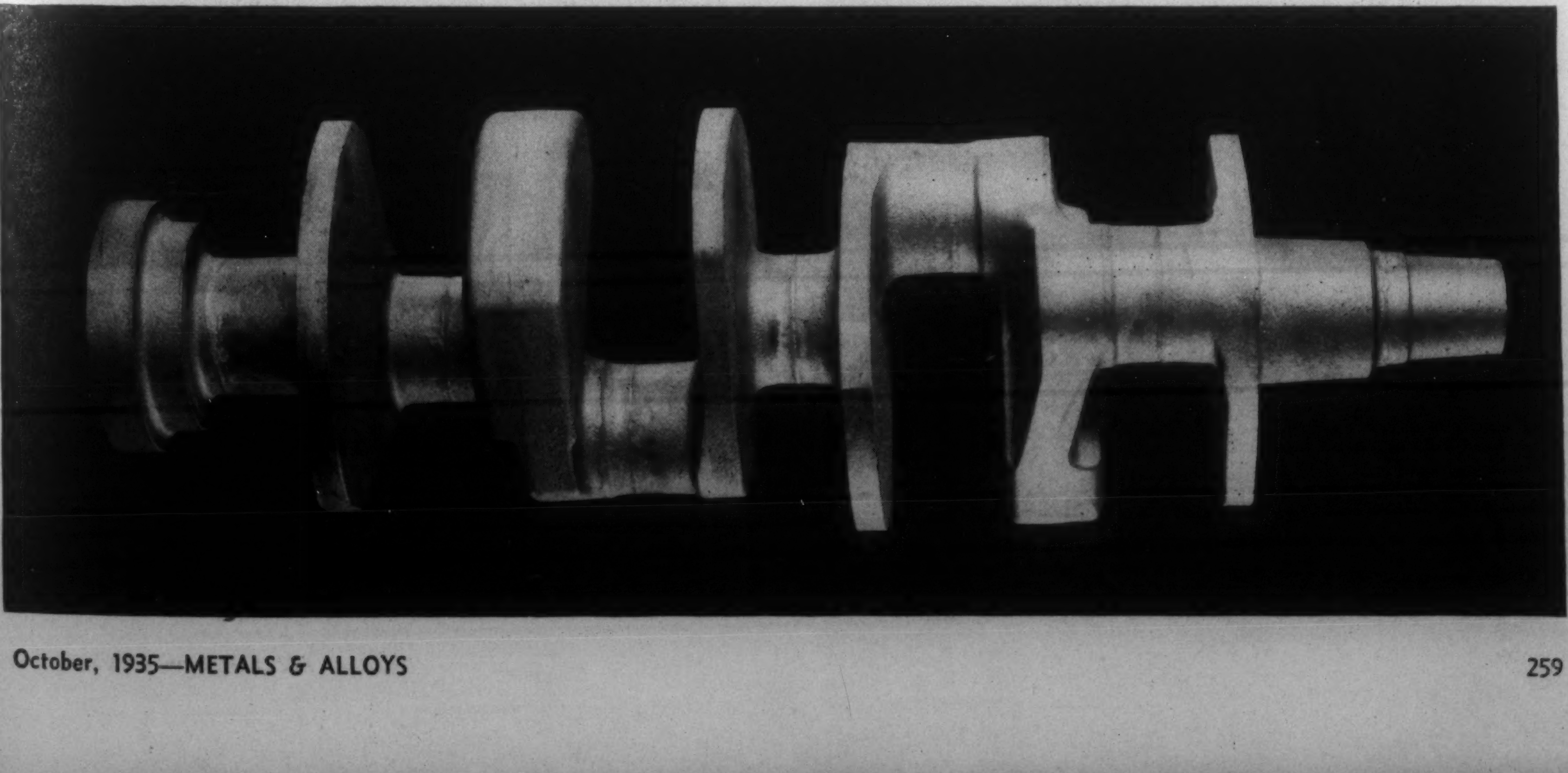
Desirous of improving the performance and life of these shafts, as well as reducing costs, experiments were instituted of an exploratory nature, with the idea of using some type of casting.

Die Casting Not Successful

Die casting was first attempted and the forging steel composition was used. In die casting this steel, several difficulties were encountered, principally shrinkage in the heavy sections and a burning-in of the steel to the die. Reducing these sections offset shrinkage troubles but the burning-in persisted.

Nevertheless changes in analysis were tried with the aim of increasing the casting properties. Pouring at a lower temperature to reduce the tendency to burn-in was attempted and silicon was increased so as to de-

The Ford V-8 Cast Metal Crankshaft.



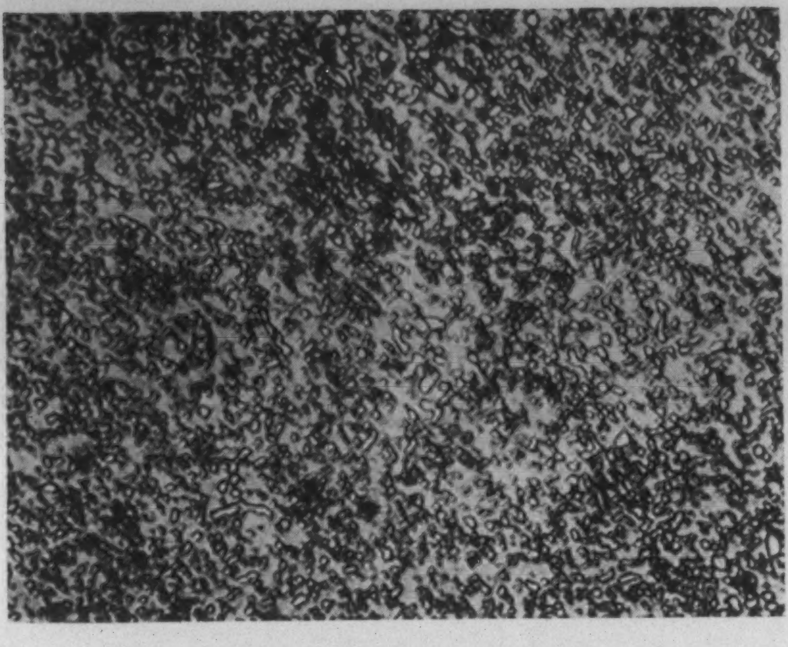


Fig. 1.—Structure of the First Alloy Developed for the Ford V-8 Cast Crankshaft. Magnification, 100 diameters.

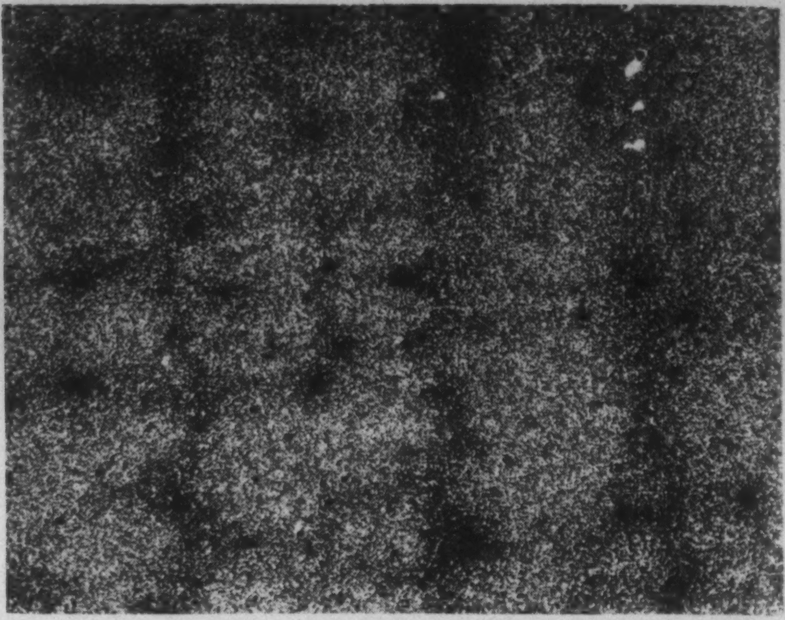


Fig. 2.—Same as Fig. 1 except at a magnification of 500 diameters.

crease the tendency to shrink. The carbon was raised to about 2.50 per cent and the silicon to 2.00 per cent. This composition chilled to a white iron in the die, necessitating annealing so as to render the metal machinable to a Brinell below 300.

In annealing, however, excessive warpage resulted —to such an extent that straightening was neither possible nor practicable. The shafts of this composition were very heavy, though cut out as much as possible, and there was still too much shrinkage, though the burning-in of the metal in the die was practically eliminated. Because of the excessive warping during heat treatment, it was decided that the die casting of as heavy a product as a shaft was impossible.

The next step in the development of the cast shaft was casting it in green sand. A metal containing approximately 2.00 per cent carbon and 1.75 per cent silicon was used, with varying percentages of chromium, molybdenum and even nickel during the experimental trials. This was the initiation of the alloy product.

This composition also resulted in a white iron in the green sand which necessitated annealing. Here again warping of the shafts was encountered, but it was by no means as excessive as in the first trials referred to when die casting was the method tried. It was still too much to be practicable. In addition, to secure a solid product in green sand, a large percentage of metal had to be provided in risers and gates which resulted in excessive cleaning costs and special sands. It was also found that a multiple mold in green sand was not feasible. Unless a multiple mold could be used, the cost would be too high.

Some of the Problems Encountered

At this point in the research it became apparent to the metallurgists that a composition would have to be perfected which would be amenable to a minimum amount of heat treatment so as to reduce warpage, one which would insure proper machining properties, adequate strength and also proper wearing qualities. Besides these problems—not easy to solve—there had to be a casting method which would permit lower operating costs than forging.

It was decided that the solution of this foundry problem rested in the use of a multiple mold of dry sand. With the employment of this type of mold there was reason to assume that there would be no run out casting as well as no chilling effect. At the same time a stronger mold, capable of being set up in any position would be the result.

The first analysis of steel, experimented with in such a dry sand mold, was the same as was used for the forging—a typical carbon steel for forging. Due to the metal burning-in to the sand and to defects in

Fig. 3.—Structure of the Second Alloy Developed and Now Used in Ford Engines. Magnification, 100 diameters.

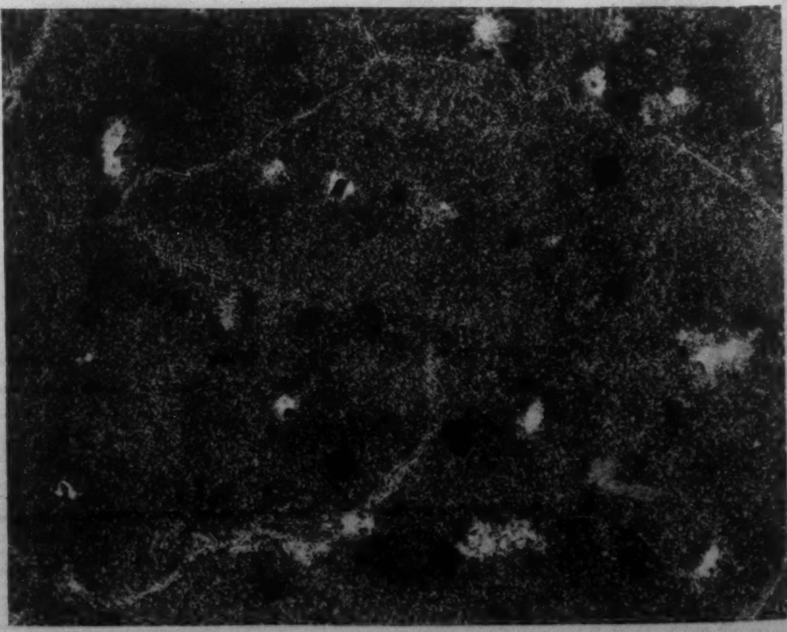
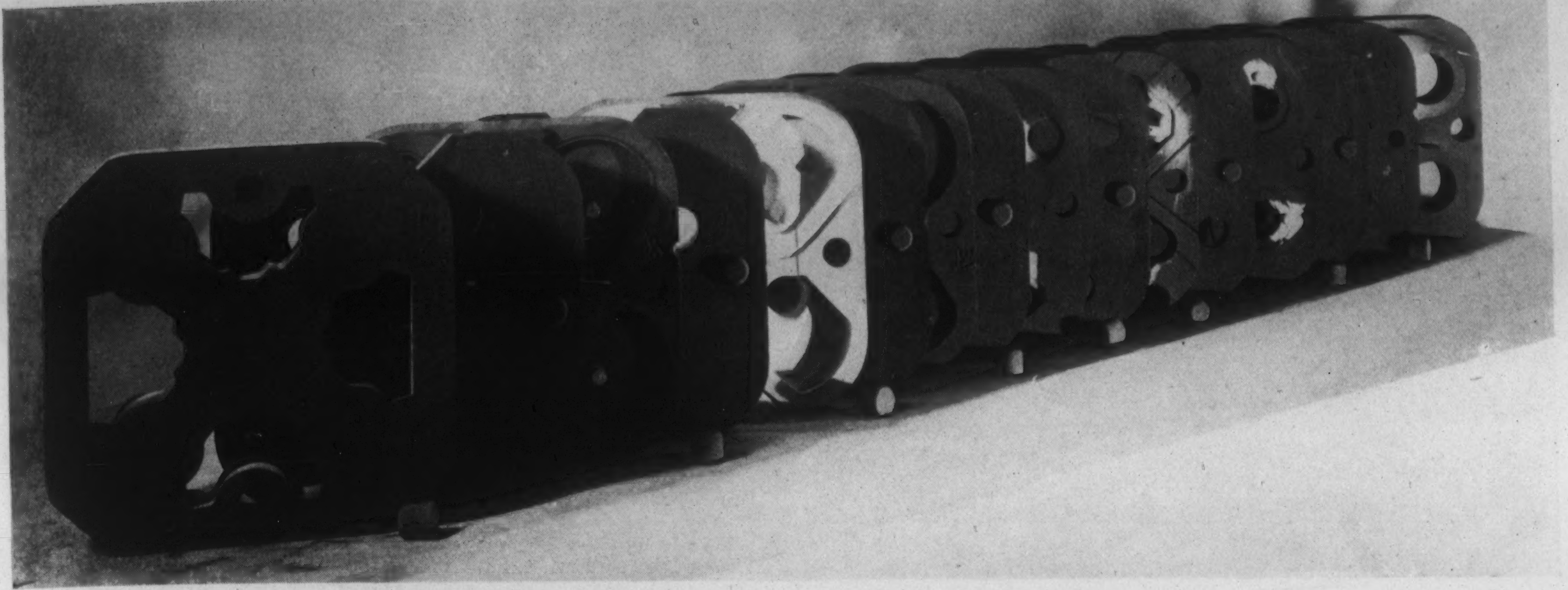


Fig. 4.—Same as Fig. 3 except at a magnification of 500 diameters.



The 16 Dry Sand Cores Which Go to Make up a Multiple Mold for 4 Shafts.

the casting, this was discarded. It was then decided to continue with a relatively low-carbon content (0.50 to 1%) and to raise the silicon as high as 2.00 per cent,—conceived of as an attempt to improve the casting properties. The higher silicon, along with lower carbon, did not benefit the casting properties.

Reasons for Adding Copper

It was found that something would have to be added with the silicon to secure the casting properties desired. But by increasing the carbon to about 2.00 per cent, the metallurgists found that again they had to cope with the annealing problem—warping. It was then decided to add copper to alloy with the silicon and increase the fluidity. This Cu-Si combination produced the results expected—increased fluidity and better casting properties—even with the comparatively low carbon.

A Set of Molds, Each of Which Contains the 16 Cores Stacked in Plates. These sets are carried on a conveyor through the core assembly, casting and cooling processes. Before the leader core is put in place, sheets of paper are laid over the sprues to prevent entrance of loose sand.

In the course of these experiments with additions of copper, the quantity used varied from 0.75 to 3.00 per cent. It was finally decided that a copper content of 1.50 to 2.00 per cent gave the best fluidity; with the copper as high as 3.00 per cent, lower physical properties resulted. A decision to use 1.50 to 2.00 per cent copper was reached as insuring satisfactory fluidity and adequate physical properties.

Other factors affecting the decision were that copper graphitizes the carbon when this is up to about 1.50 per cent, that it promotes the formation of small nuclei of primary graphite, and that no deterioration of physicals ensues. Also the graphitizing effect of copper aids in cutting down the annealing time so that warping was a less serious problem, except when it could be taken care of by using a warped pattern.

Although crankshafts were cast with the carbon as low as 0.50 per cent, with the silicon 2 per cent and the copper 2.50 per cent, it was found best to raise the carbon to obtain still better casting properties, at the same time not sacrificing physical values. An added consideration was the acquiring by this means of greater wearing qualities over those obtainable from the lower carbon content. This increased wear resistance from the presence in the higher carbon is explained as due to the presence of finely distributed secondary graphite and to very thin lines of cementite around grain boundaries, after annealing at 1650 deg. F., followed by air quenching, and a draw after heating at 1400 deg. F. The Brinell hardness is then 255 to 321. Even with this low machinable Brinell, good wearing properties prevail due to the structure containing graphite and cementite.

Three Molds, Each Containing Four Crankshafts, Are Poured from Each Ladle of Metal.

Removing the Sand After Pouring the Molds.

Effects of Adding Chromium

It was realized that excellent wearing qualities were possible by the addition of chromium which increases the cementite. But this would tend to be unmachinable with a high chromium forming too much cementite. Lower physical properties would also ensue. By exhaustive wear tests in motors, the Ford investigators found that a spheroidized, pearlitic matrix with secondary graphite embedded and surrounded with very thin lines of cementite would give satisfactory wearing qualities. Such a structure was found to be easily machinable and to possess high physical properties. Such a structure was obtained by adding about 0.50 per cent Cr to the mixture thus far developed. Higher chromium causes poor machinability and a lower chromium percentage effects a complete disappearance of the cementite lines.

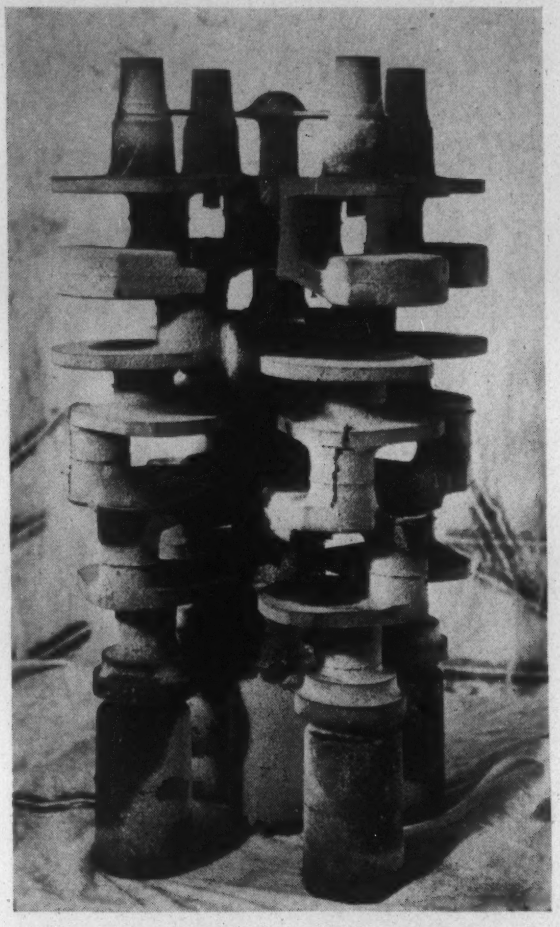
As a result of the experiments thus far related and for the reasons outlined, the following approximate composition, Alloy No. 1, for cast crankshafts was decided upon:

Shaft Alloy No. 1	Per Cent
Carbon	1.25 to 1.40
Manganese	0.50 to 0.60
Silicon	1.90 to 2.10
Copper	2.50 to 2.75
Chromium	0.35 to 0.40
Phosphorus	0.10 max.
Sulphur	0.06 max.

This analysis was successfully cast for some time in multiple molds of dry sand. It was found, however, that this alloy was not as resistant as desired to shock or impact. This condition resulted in a decision to subject every casting to a 100 per cent impact test to detect casting flaws or unsatisfactory heat treatment.

Changes in Original Analysis

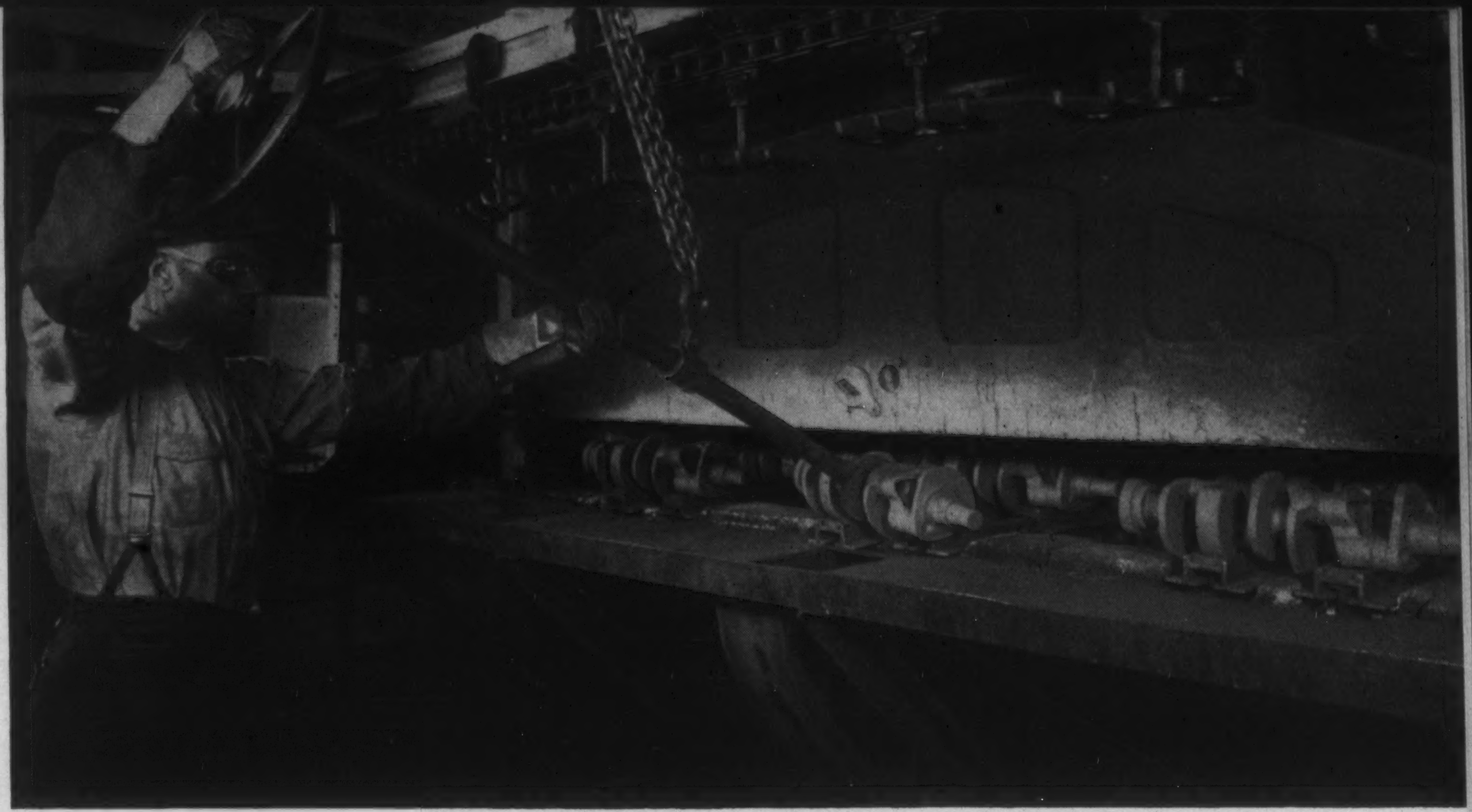
Although the use of shafts of this analysis did not result in any trouble in the motor, it was desired to improve the impact properties. By means of other experiments it was found that by lowering the percentage of silicon, the impact values were improved, retaining at the same time all other given properties. The copper content was lowered also for the same reasons. These decisions resulted in an alloy shaft of the following composition (Alloy No. 2):



A Typical Group of Four Shafts with Attached Gates and Risers and Resting on the Risers in the Furnace.

Shaft Alloy No. 2	Per Cent
Carbon	1.35 to 1.60
Manganese	0.60 to 0.80
Silicon	0.85 to 1.10
Copper	1.50 to 2.00
Chromium	0.40 to 0.50
Phosphorus	0.10 max.
Sulphur	0.06 max.

Tempering the Shafts from 1650 deg. F. to 1400 deg. F.



Removing the Shafts from the Heat-Treating Furnace After Treatment is Completed.

By this time the machine shop staff had become more efficient in machining this new alloy, and, although this analysis resulted in a little more cementite present, no difficulty has been experienced in machining.

Heat Treatment Used

Shafts of this composition are heat treated in gas fired furnaces as follows:

Heat to 1650 deg. F., holds for 20 min.
Air quench to a minimum of 1200 deg. F.
Reheat to 1480 deg. F., and hold 1 hr.
Cool in the furnace to 1000 deg. F. in another hour.

The alloy for casting is melted in four 15-ton electric furnaces according to the latest approved practice. The charge is made up of approximately 50 per cent return shop scrap (gates and risers) and 50 per cent steel scrap. Illustrations accompanying this article clearly depict the construction of the multiple mold, made entirely of cores, and the general foundry practice.

Physical and Other Properties

The physical properties of the alloy in the cast crankshaft are as follows:

Results on **Test Bars:**			
Transverse (1 in. sq. in 12 in. centers):			
Breaking load	9,565 lb.	and	9,330 lb.
Deflection	0.420 in.	and	0.430 in.
Static:			
Elastic limit, lb. per sq. in.	91,000		93,500
Tensile strength, lb. per sq. in.	108,000		107,000
Elongation, per cent	3.0		2.5
Red, of area, per cent	2.5		2.0
Brinell No.	269		269
Torsion **Tests on Shafts:**			
Elastic limit, lb.	88,200		96,500
Tensile strength, lb.	128,000		130,000
Twist at E. L.	9 deg.		6 deg.
Twist at T. S.	20 deg.		25 deg.
Brinell No.	225	to	321

Impact **Test on Shafts:**
Shafts must stand a drop of a 50-lb. weight falling 40 in. to the flange at center of main bearing while supported on two end main bearings.

Photomicrographs, Figs. 1 to 4, reveal the structure of the two alloys discussed in the foregoing paragraphs. Figs. 1 and 2 are the first alloy that was used or Alloy No. 1. Figs. 3 and 4 represent the structure of Alloy No. 2, the one now used.

A Modified Composition in Other Auto Parts

The incorporation of this new alloy, with some modifications, in other products than the crankshaft for the Ford V-8 has been inaugurated. The parts now being made, as castings in place of forgings, of an alloy similar to that in the shafts, include brake drums, truck auxiliary spring supports, generator front-end plates and several more small parts. These are all cast in green sand.

The composition developed for the brake drums is as follows:

	Per Cent
Carbon	1.40 to 1.60
Manganese	0.40 to 0.60
Silicon	0.90 to 1.10
Copper	1.50 to 2.00
Chromium	None
Phosphorus	0.10 max.
Sulphur	0.08 max.

The heat treatment given these brake drums is heating to 1600 deg. F., held there for 30 min., then cooled rapidly in the furnace to 1450 deg. F., followed by cooling in 2 hours to 1350 deg. F. and then in 1 hour to 1000 deg. F. The resulting physical properties of this metal are:

Elastic limit, lb. per sq. in.	69,400	70,300
Tensile strength, lb. per sq. in.	85,600	85,100
Elongation, per cent	5.0	7.0
Brinell No.	196	228

A higher ductility of the metal for brake drums is necessary and the alloy must be capable of machining more rapidly than in the case of the crankshafts.

The metallurgists state that, by using copper, they have been able to very successfully cast some parts of very low-carbon metal—as low as 0.30 per cent C. With such metal it has been possible to successfully cast clutch pedals and similar castings, formerly forgings. Plans are contemplated which involve the casting of some products which will later be carburized.

Economy and Other Results

By the adoption of the new alloy for crankshafts, the savings in cost of production are stated to be considerable. Their use in actual installations has been very successful. The new cast shaft weighs about 10 per cent lighter than the forged shaft. The forged shaft weighed approximately 83 lb. in the rough and 66 lb. after machining. The cast shaft weighs 69 lb. before machining and 60 lb. finished. Thus the amount of metal removed from the forging was 17 lb. as against only 9 lb. for the casting—a decided saving in itself. Since September, 1933, over 1,500,000 cast shafts have been produced and assembled. At one time the production was 6,500 shafts per day.

Development of this new alloy as a crankshaft, together with its application to other parts and its future possibilities, is emphatic testimony to the ingenuity and resourcefulness of the Ford metallurgists and engineers in perfecting a new product which shall be even better than the old and made at less cost. It is indeed a fascinating story in metallurgical progress.

Manganese and Copper Additions to "18 and 8"—Armstrong Metal

By LEONARD C. GRIMSHAW

Latrobe Electric Steel Co., Latrobe, Pa.

CORROSION RESISTANT steels, containing approximately 18 per cent chromium and 8 per cent nickel, have had increasingly wide use during the past ten years. These steels possess their best corrosion resistant properties when they are in a uniform, austenitic state. After any sort of mechanical working below 1700 deg. F., they are no longer uniformly austenitic, but become so after heating to a temperature between 1900 and 2150 deg. F., and cooling fairly quickly and uniformly. Subsequent mechanical work, or haphazard heating, makes them revert to a mixed structure. In this condition they are no longer corrosion resistant to their fullest extent.

For many applications, it has been found impractical to heat treat the finished product, and so make it uniformly austenitic. The finished product may be of very large size after being mechanically deformed or welded together, and without treating at the relatively high temperature of 1950 to 2150 deg. F., the harmful effects of the mechanical working, or heat of welding, cannot be eliminated. Or it may be impossible to heat treat a smaller product, if it has been welded into position in the field.

In an effort to produce an alloy that would not require any such final heat treatment of the product to make it fully corrosion resistant, P. A. E. Armstrong developed one which is named after him: "Armstrong Metal." Most of the later development was carried out under the writer's supervision.

This alloy is essentially "18-8" to which has been added copper and manganese, the manganese always being in excess of the copper, (U. S. Patent No. 1,962,702). With the manganese and copper in suitable proportions, such a material is austenitic (non-magnetic) even after very severe cold work, or after welding. A typical analysis of the alloy is:

	Per cent
Carbon	0.10
Manganese	4 to 6
Chromium	17.5
Nickel	8.0
Copper	2.9

Effect of Copper

The good effect of copper on the corrosion resistance of high chromium steels was noted by Saklatawalla[1] and Saklatawalla and Demmler[2]. They commented that the corrosion resistance of the copper-containing steels was not so dependent upon the condition into which they were put by heat treatment as in the plain chromium steels. Their copper contents were relatively low.

Becket and Franks[3] have briefly mentioned a steel of this general character, containing:

	Per Cent		Per Cent
Chromium	17 to 19	Copper	0.7 to 1.1
Manganese	5 to 6	Silicon	0.2 to 0.5
Nickel	4 to 5	Carbon	0.12 max.

Also a similar one was suggested with chromium raised to 20 per cent or more, and nickel to 6 per cent. Becket's steels differ from the Armstrong alloy in having lower nickel and much lower copper. Our tests show that very useful properties are imparted by retaining the nickel content of 18-8 and holding the copper at a much higher level.

The carbon in the Armstrong alloy is usually kept as low as commercially practical. The chromium may safely run a little lower than is usual in "18-8." There has been a tendency for several years to raise the chromium and the nickel content of "18-8," but in this modification metal the chromium may be kept between 17 and 18 per cent, and the nickel need not be over 8 per cent unless desired. This tends to offset the increased cost of the high manganese and copper additions. Manganese additions can be made from ore, using silicon or aluminum as reducing agents in the slag.

In the best all purpose analysis, the manganese is between 4 and 6 per cent, and the copper 2.9 per cent. For special uses the manganese can be varied between 1.5 and 12 per cent, and the copper from 1.5 to 3 per cent. The higher manganese, up to 12 per cent, increases the resistance of the alloy to sulphuric acid solutions, but lowers the resistance to other chemicals, and also increases the melting cost. The manganese is better lower than 4 per cent when resistance to nitric acid is of primary importance.

Ratio of Manganese to Copper

The important thing is that the ratio of manganese to copper should be 3:2, or 2:1. But when we raise the manganese above 6 per cent we cannot keep to this ratio, because such alloys cannot be forged when the copper exceeds 3 per cent.

The silicon is usually low, but can well be increased to 3 per cent with improvement in certain important properties. Silicon above 3 per cent in this alloy has thus far proved impossible to forge, but further work along this line should iron out this difficulty. The difficulty of forging such alloys containing high manganese and over 3 per cent of copper is more understandable, and probably will prove impossible of solution on a commercial scale.

Armstrong metal forges easily. The temperature usually used for the first cogging is 2100 deg. F., subsequent coggings being made at slightly lower temperatures. Such a wide range of working temperatures is permissible that small experimental ingots, containing not over 3 per cent of copper, have been forged at temperatures anywhere between 1400 and 2200 deg. F., but alloys containing more than 3 per cent copper could not be forged at all.

The ingot surface is good and free from scabbiness. The alloy has easily been rolled into sheets and bars, and cold drawn into wire. The losses on a plate mill have proved exceptionally low, especially those losses due to seams, rags, and tears.

Armstrong metal is non-magnetic "as forged" or "as rolled." After heating to 1900 deg. F. and cooling in air, oil, or water, it is non-magnetic even after subsequent severe cold work. Even the metal of a pulled tensile test specimen, cold worked to the breaking point, remains non-magnetic unless the manganese is on the low side; that is to say, 4 instead of 6 per cent manganese, in conjunction with 3 per cent copper.

In the "as forged" condition, the hardness will be around 150 to 170 Brinell. Such a statement is hard to make with exactitude. Like "18-8," the size of the piece and the finishing temperature are very important if any particular hardness is to be obtained.

Effect of Heat Treatment

After heating to 1950 deg. F., and cooling by any means, the alloy is very soft, being about 140 Brinell or even less. When next given a draw to between 600 to 1100 deg. F., there is evidence of precipitation hardening. The alloy is still non-magnetic, still corrosion resistant to its fullest extent, and yet has increased in hardness to between 160 to 180 Brinell. In this state the alloy machines at its best, giving a fine finish, free from tears. In no state is it difficult to machine. At no time are difficulties encountered as in the machining of "18-8," but it is after it has been quenched[4] and drawn to above 600 deg. F. that it is most easily machined, and it is still non-magnetic and fully corrosion resistant.

The alloy takes an excellent high polish, and possesses a very pleasing color. It has an appearance more like that of nickel or silver than have ordinary stainless steels, as it lacks a bluish tinge. This is probably due to the copper content.

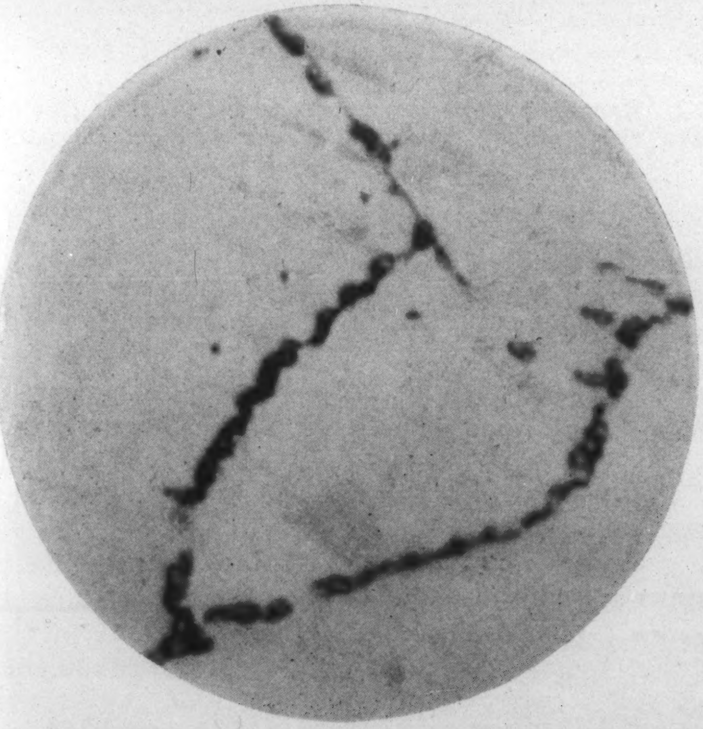


Fig. 1. Structure of Armstrong Metal as Rolled. Etched electrolytically in sodium cyanide solution. Magnification 2300 diameters.

The quenched alloy shows a somewhat lower ultimate strength than quenched "18-8," but has an increased proportional limit and ductility. After forging or rolling, it will possess an ultimate strength of around 90,000 lb. per sq. in., 42 per cent elongation, and 66 per cent reduction of area, with a hardness of 170 Brinell. It is apparently impossible to work harden it, as can be done with "18-8," and so produce high ultimate strengths in the neighborhood of 140,000 lb. per sq. in.

After oil quenching from 1950 deg. F., the ultimate strength will be around 80,000 lb. per sq. in., the elongation 52 per cent, the reduction of area 71 per cent, and the Brinell hardness 126. The proportional limit runs 6,000 lb. per sq. in. higher than that of austenitic "18-8."

Armstrong metal is therefore essentially ductile, yet possesses plenty of strength for uses where both strength and ductility are expected. The important property, proportional limit, is high. Whereas, as has been stated, "18-8" can be work hardened and made to possess high ultimate strengths that are impossible to Armstrong metal, it must be remembered that such strengths are only obtained at a great sacrifice of corrosion resistance, so that where corrosion resistance is the important factor, "18-8" has no great advantage of strength over this alloy.

The Corrosion Resistant Properties

The alloy provides a corrosion resistant material that is fool proof, and its strongest points are resistance to solutions of sulphuric acid and to intergranular corrosion. The Table gives comparative results of tests, in cold 10 per cent sulphuric acid, of several interesting alloys. The samples were immersed in the solution for a total period of 100 hr., and were removed, dried, weighed, and the solution renewed, five times during this period.

Table of Comparative Results of Corrosion Tests of Several Alloys

	Analysis							Loss in gms. per sq. in. surface, 100 hr. in cold 10%
Steel	C	Si	Mn	Cr	Ni	Cu	Condition	H_2SO_4
A	0.11	0.36	0.49	17.91	7.74	None	As rolled,	3.9258
							2050 deg., oil	0.5422
B	0.13	0.24	0.80	23.96	12.97	None	As rolled,	0.7556
							2050 deg., oil	0.6073
C	0.09	...	...	18.15	7.86	None	As forged,	0.2068
							2050 deg., oil	0.2078
D	0.12	0.38	9 95	18.08	8.27	None	As forged,	2.7363
							1950 deg., oil	0.3626
E	0.10	0.39	2.95	17.14	8.17	2.9	As forged,	0.0285
							1950 deg., oil	0.0262
F	0.10	0.31	4.61	17.46	8.25	2.9	As forged,	0.0170
							1950 deg., oil	0.0112
G	0.08	0.39	5.93	17.46	8.25	2.9	As forged,	0.0155
							1950 deg., oil	0.0081
H	0.09	0.34	11.65	17.80	8.25	2.95	As forged,	0.0108
							1950 deg., oil	0.0038
I	0.07	2.21	5.44	18.65	8.49	2.9	2000 deg., oil	0.0341

Admittedly the tests on "18-8" in the "as rolled" or "as forged" state mean very little, since the alloy is not stable, but where Armstrong metal is tested "as forged," results can be duplicated for the alloy is stable.

Steel A (in the Table) is a commercial basic electric furnace heat of "18-8." Disregarding the "as rolled" test as having very little meaning, we see that after heat treatment the losses are much greater than for Steel G, whether Steel G is heat treated or not. Even Steel B, a commercial heat of "24-13," is poorer than Steel G.

Steel C is a special heat of "18-8" melted in a 30 lb. induction furnace and forged to ¾ in. sq. Here the losses are lower than for the commercial heat, but not comparable to Steel G.

Steel D shows that the high manganese is useless without its partner, copper.

A large number of alloys, not listed in the Table, indicate that 4 per cent or more manganese is required with the 2.9 per cent copper. When the manganese reaches 4 per cent, the losses in sulphuric acid solutions suddenly drop to about half the losses for alloys with less than 4 per cent manganese (Steels F and E). Armstrong metal is a balanced alloy. The higher the manganese, the better the alloy resists sulphuric acid, but Steel G is the most useful, the cost of manufacture of Steel H being higher: out of proportion to its increased usefulness except for special applications.

Armstrong metal must be heat treated before exposure to boiling nitric acid, but after this heat treatment it can be electric welded and still remain almost immune to nitric acid attack. The recommended treatment for plates to be electric welded and later exposed to nitric acid, or to conditions causing intergranular corrosion, is a draw at 1200 deg. F. for 1 or 2 hr.

Intergranular Corrosion

Intergranular corrosion, particularly in the vicinity of parts that have been electric welded, is a serious drawback to the wider use of "18-8." To resist intergranular corrosion at all satisfactorily, "18-8" must be heated to the relatively high temperature of 2000 deg. F., and cooled uniformly, preferably by quenching in oil. Large sheets, and large products assembled by electric welding, cannot conveniently be given this heat treatment, as very few large furnaces in this country will heat above 1600 deg. F. and in those that do, trouble arises because the sheets to be heated sag at such high temperatures. Armstrong metal can be made resistant to intergranular corrosion by taking the "as rolled" sheet, and giving it a draw at 1200 deg. F. This temperature is within the compass of annealing furnaces able to take the largest sheets made. Subsequent cold work or electric welding may be done, and no further heat treatment is necessary.

The low temperature treatment is of great advantage for clad sheets of the improved alloy. It is below the hardening temperature, and below the grain growth temperature, of any steel that might be used for a backing material for a stainless faced sheet. The high temperature necessary to heat treat "18-8" would ruin most backing materials in clad sheets. Intergranular corrosion tests, made by immersing a sample in a boiling solution made up of 10 parts $CuSO_4$ by weight, 10 parts H_2SO_4 by volume, and 80 parts water, are extremely interesting.

When Armstrong metal is in the "as forged" state, or is given an oil quench from 1950 deg. F., it completely withstands the test for at least 270 hr. The test has not yet been continued longer. The "18-8" alloy is liable to fail during this period when in the "as forged" state, but withstands it successfully after water quenching from 2050 deg. F.

However, the severe intergranular corrosion test for "18-8" is when the steel has had a "draw" at around 1200 deg. F. for a long time. The steels tested were all drawn at 1200 deg. F. for 70 hr. Steels F, G, and I, in the "as forged" state, then drawn for 70 hr. at 1200 deg. F., only began to show signs of failure after 54 hr. of testing; "18-8" failed in 3 hr. under the same conditions.

After oil quenching from 1950 deg. F. and drawing as above, Steels F and G withstood the test for 22 hr. and then began to fail, while "18-8," drawn after a 2050 deg. F. water quench, had failed quite badly after 22 hr. In fact, the "18-8" was no longer perfect after 12 hr. Steel I, a high-silicon Armstrong metal was perfect after 54 hr., when the test was discontinued.

As Forged vs. Oil Quenched

The question will immediately be asked: "Why is Armstrong metal (Steels F and G) better in the 'as forged' and drawn state, than in the 1950 deg. F. oil quenched and drawn state?" The answer to this becomes clear as we draw our own conclusion from the paper by Rollason.[5] In this paper we see that severely cold worked "18-8," drawn at 1200 deg. F., withstands intergranular corrosion much better than quenched and drawn "18-8." In the case of Armstrong metal in the "as forged" and drawn state, the same sort of coagulation of carbides and diffusion of chromium to depleted areas takes place as in the severely cold worked "18-8." This is not to say that the hot work places Armstrong metal in exactly the same state as cold worked "18-8," for this is not so; this alloy, hot worked, is quite non-magnetic; but it does seem naturally to possess the property of having its carbides easily coagulated and its chromium easily diffused by the draw, which occur in "18-8" only after severe cold work.

Electric welding of the new alloy is very easy. The deposited metal is fully corrosion resistant, and free from any entrapped air bubbles. The weld metal is non-magnetic, even after planing or chipping off.

Scaling tests show that Armstrong metal scales a great deal less than "18-8" at 1600 deg. F., and that the scale formed is very closely adherent, like on silcrome steel, but the alloy is no better than "18-8" at a temperature of 1800. deg. F. The addition of silicon greatly improves the non-scaling properties of both this alloy and "18-8."

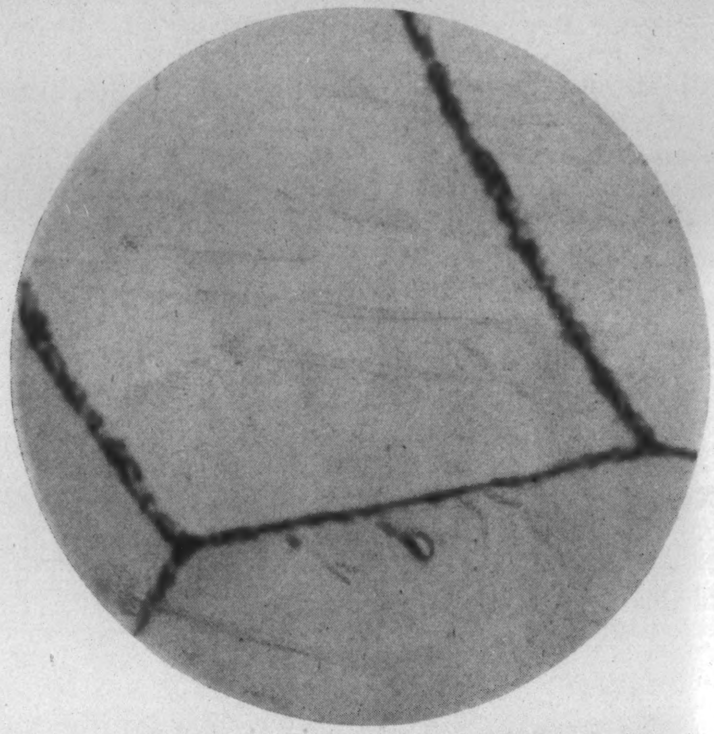


Fig. 2. Structure of Same Metal as Rolled and Drawn at 1200 deg. F. Etched electrolytically in sodium cyanide solution. Magnification 2300 diameters.

It is not claimed that the new alloy will replace "18-8." But for certain uses, and particularly when heat treatment of a cold worked, welded, or clad product is impossible or impractical, Armstrong metal will prove very useful.

Figs. 1 and 2 are photomicrographs of Armstrong Metal "as rolled" and "as rolled and drawn at 1200 deg. F." These samples show great carbide precipitation but the structure (Fig. 1) will withstand the intergranular corrosion test, as described in this article, for at least 270 hr. and the other structure (Fig. 2) only begins to fail after 54 hr. The regular "18 and 8" type, in the same condition as either one of these samples, would have failed much sooner, although the appearance of the Armstrong metal is such that, were it "18 and 8" it would be rejected on structure alone. No one would bother to test "18 and 8" if it showed such carbide precipitation.

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[1] Saklatawalla, B. D. "Ferrous Alloys Resistant to Corrosion." The Iron Age, Vol. 13, 1924, p. 1209-1213.

[2] Saklatawalla, B. D., and A. W. Demmler. "Chromium Copper Steels as Possible Corrosion Resisting Ferrous Alloys." *Trans.* A.S.S.T., Vol. 15, 1929, p. 36-48.

[3] Becket, F. M., and R. Franks. Chapter on Alloys Containing Considerable Manganese, pages 497-501. The Book of Stainless Steels, edited by E. E. Thum. 20th Edit., 1935.

[4] Air cooling, or "air quenching," is sufficient for Armstrong metal, if the piece cannot be quenched in a liquid.

[5] E. C. Rollason, "Some Effects of Cold-Rolling on the Intergranular Corrosion of the '18-8' Stainless Steels." *Journal* of the Iron and Steel Institute, 1934, No. I, p. 311.

On the Structure of Armor, Ancient and Modern

By **WILLIAM CAMPBELL**

Professor of Metallurgy, Columbia University, New York

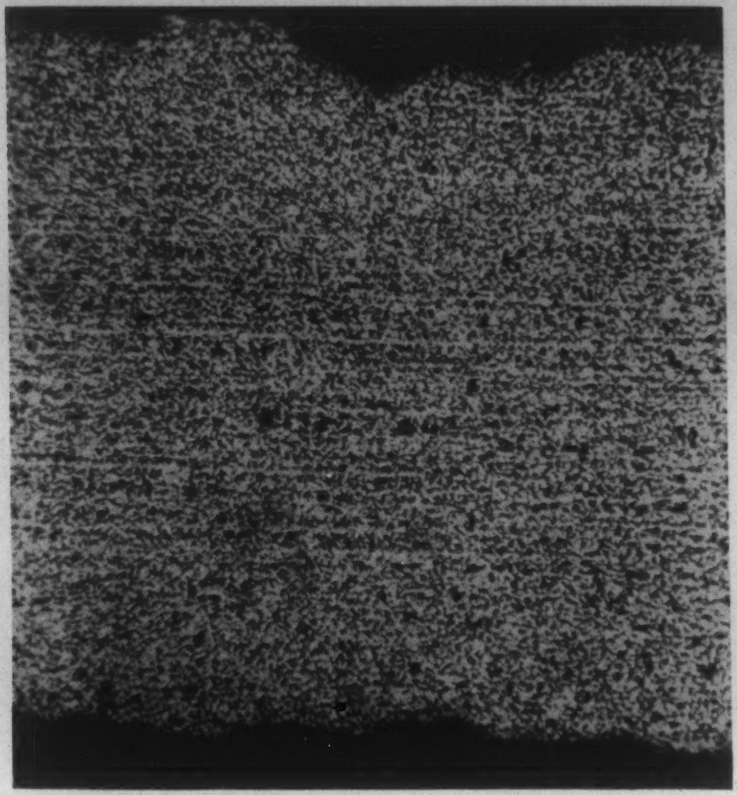


Fig. 1. From Modern French Armor. 1880 A.D. Magnification, 90 diameters. Etched in picric acid. Fine ferrite with some banded sorbited pearlite.

ONCE UPON A TIME—if you want me to be exact, just thirty-six years ago—I bought a Sorby-Beck opaque illuminator to use with my petrographic microscope and had a wonderful time examining the structure of every piece of metal I could lay my hands on. My friends use to kid me unmercifully about my queer hobby.

One of these friends had a beautiful suit of ancient armor of which he was very proud, and very kindly clipped off a tiny piece from the inside to add to my collection. Alas! its structure was that of a very thin piece of Bessemer steel, say 0.2 per cent carbon, showing the usual oxide and sulphide inclusions, and not that of charcoal hearth iron as I had expected. When I told him what I had found, his language was hardly that of a gentleman, to put it mildly.

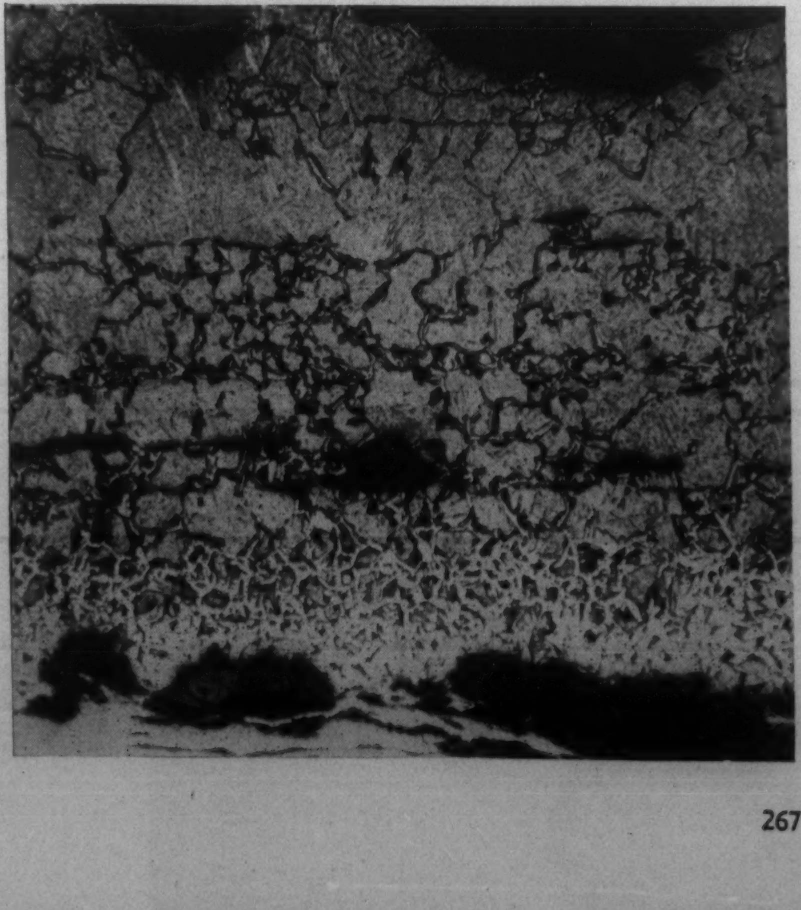
When I came to Columbia, I got to know Prof. Bashford Dean and Geo. C. Stone, both armor enthusiasts, and both promised to supply me with samples of genuine material, but the matter lay dormant until Alfred de Forest came to work in my laboratory about 1915. He got Dr. Bashford Dean, then curator of armor at the Metropolitan Museum, to furnish a number of samples which he mounted and polished with great skill and made a preliminary examination of them. Then in 1917 the subject of modern helmets versus ancient armor came up, and I made a report covering these twenty-five samples dating from about 1460 to 1700 and one piece of Modern French of 1880, for Prof., then Major, Dean, in January, 1918. As it contained over 100 micrographs, its publication was postponed till better times and like the Greek Kalends, better times never came.

A few months ago I showed it to the editor on a visit to my laboratory and like all editors he wanted an abstract—and, as everybody knows, the most difficult thing to do is to abstract one's own work. Finally the 115 micrographs were cut down to 19. And here they are.

Starting with the sample of Modern French (Fig. 1), we have the usual structure of thin sheet low-carbon steel. All the rest are charcoal wrought iron, some carburized, some not. Some contain only a trace of slag, some have so much that we must take our hats off to the ancient armorer who was able to shape such dirty metal. Some samples show genuine case-hardening, others are evidently forged from "raw" steel. Which was made from pig and which direct from ore we haven't studied.

Now we hear criticisms of some of our historic papers on the structure of steel, because these structures are so often illustrated by so-called freak samples. Well, here are samples of armor showing martensite.

Fig. 2. From an Italian Wrist-Piece. About 1460. Magnification, 90 diameters. Etched in picric acid. Carburized wrought iron.



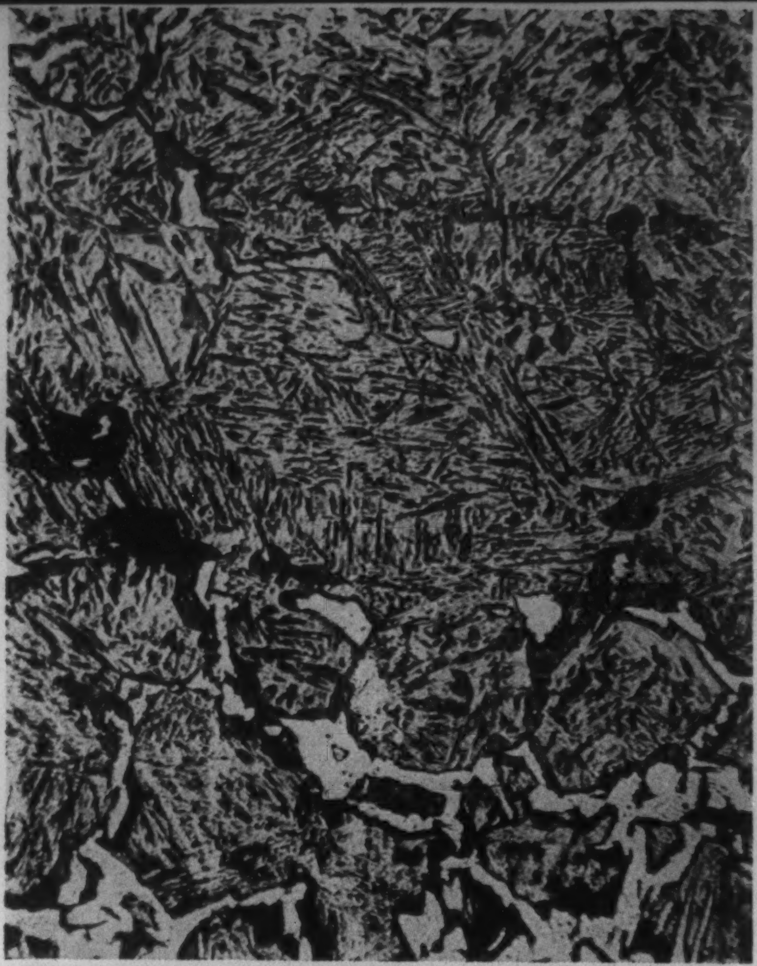


Fig. 3. (Left)—Same as Fig. 2. Magnification, 250 diameters. Etched in picric acid. Mainly martensite above; ferrite, troostite and martensite below.

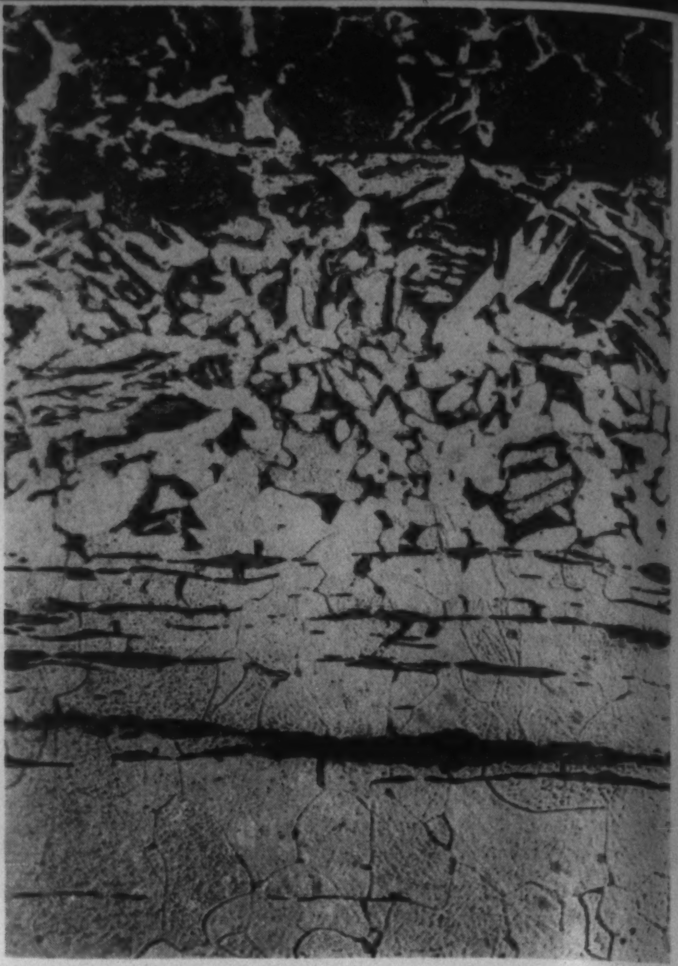


Fig. 4. (Right) — Gothic Armor. Jazeran (Scales on Cloth). Probably Italian, before 1470. Magnification, 250 diameters. Etched in picric acid. Carburized but not quenched.

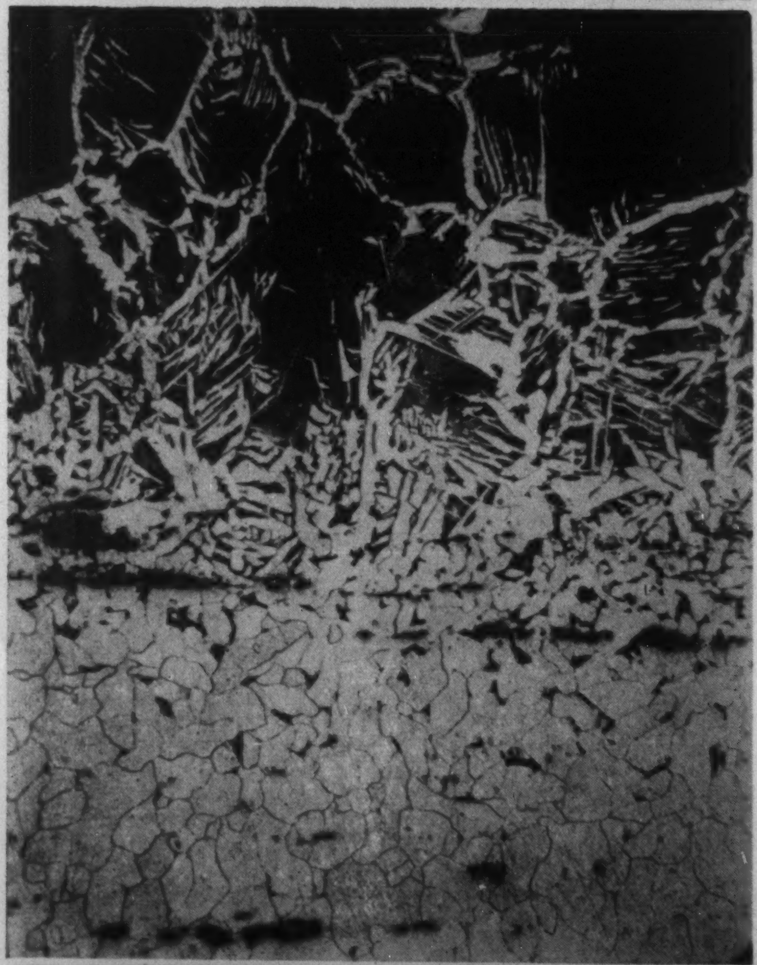


Fig. 5. (Left) — Gothic Armor. Jazeran, also. Probably Italian, before 1470. Front of body. Magnification, 90 diameters. Etched in picric acid. [See text.]

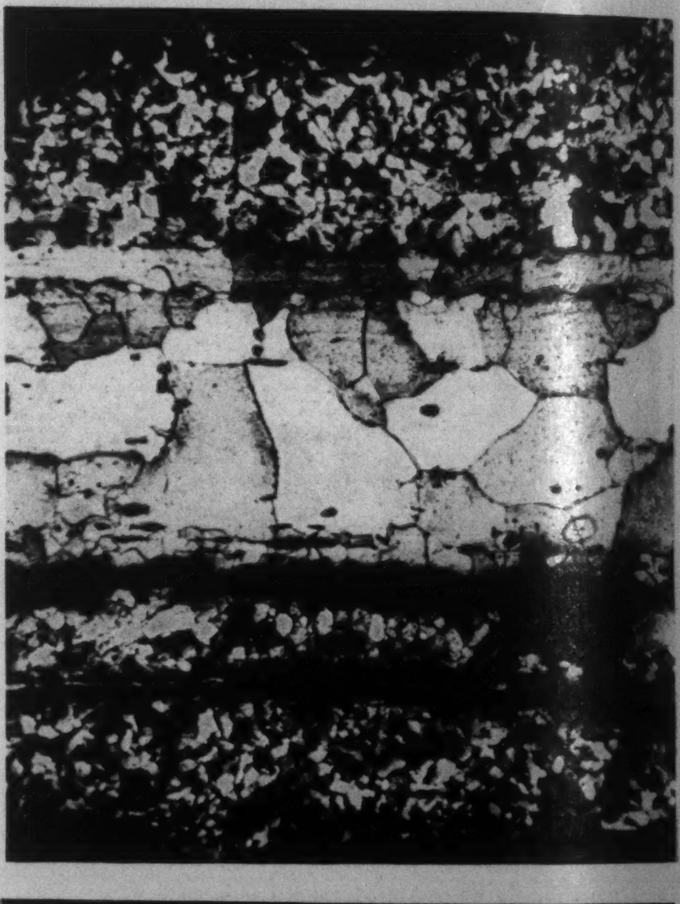


Fig. 6 (Right)—Fragment of Gothic Jazeran. Throat plate. Magnification, 90 diameters. Etched with 4 per cent nitric acid in alcohol. [See text.]

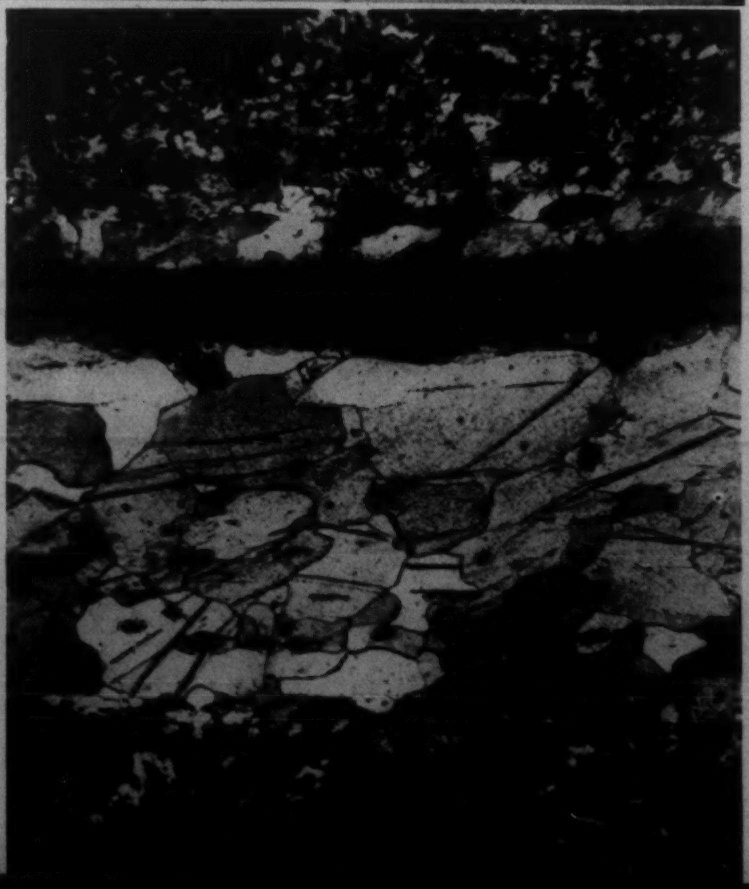


Fig. 7. (Left) — Another Section (of Fig. 6) Showing Many Neumann Bands in the Coarse Ferrite. Magnification, 90 diameters. Etched in picric acid.

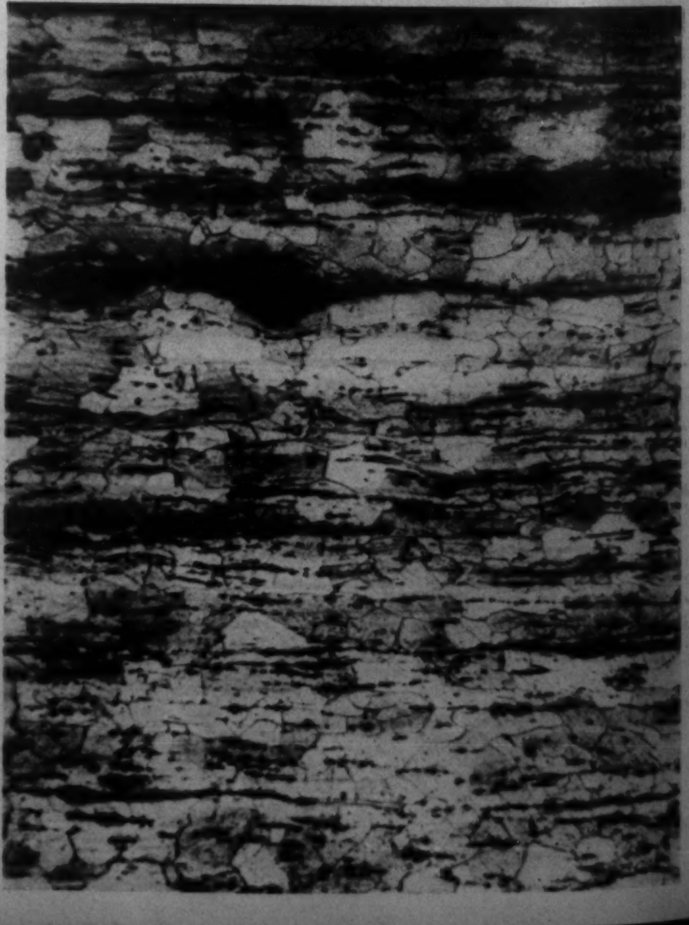


Fig. 8. (Right) — From Spanish Armor. About 1490. Magnification, 90 diameters. Etched in picric acid. Uncarburized wrought iron, full of slag. [See text.]

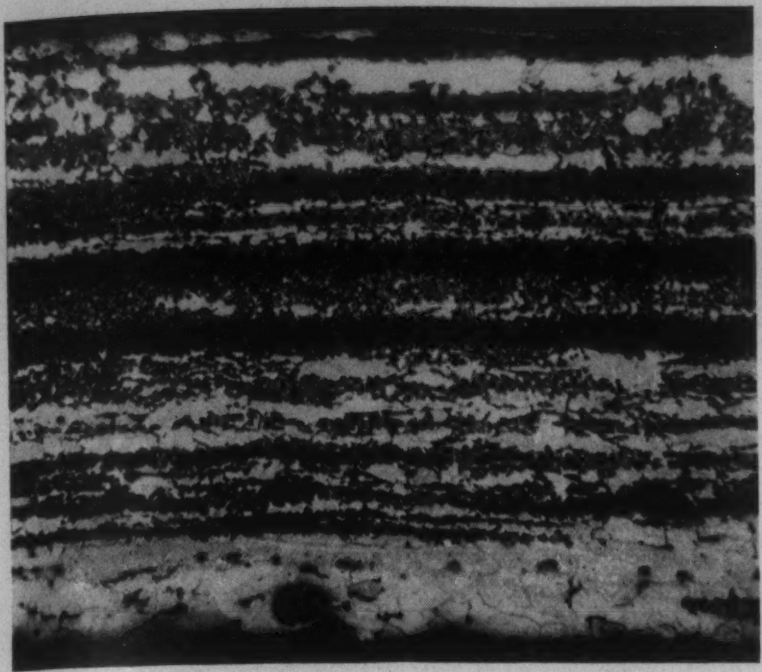
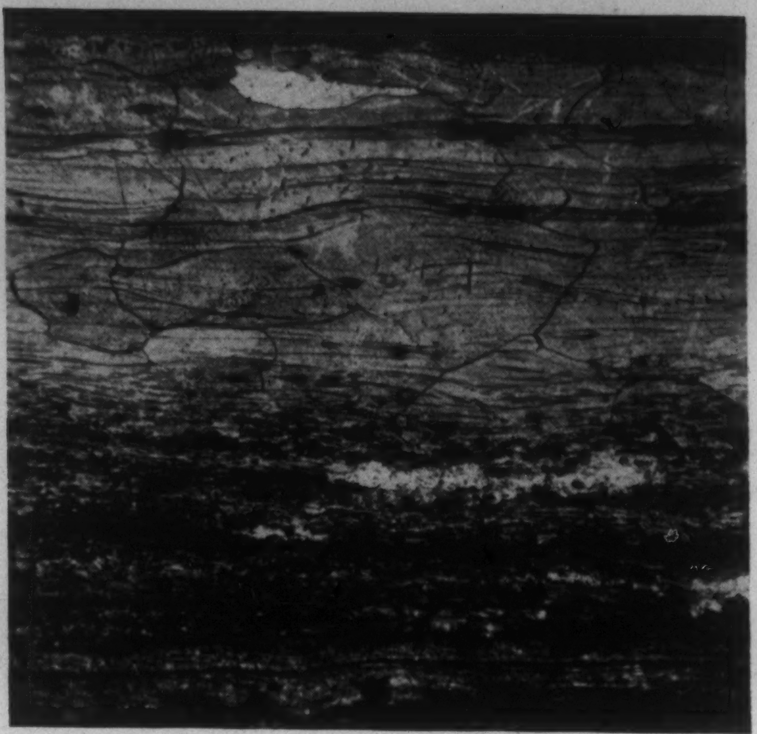


Fig. 9. (Left) — From German Armor. About 1500. Maximilian Thigh plate. Magnification, 90 diameters. Etched in picric acid. Laminated, with only a small amount of slag. [See text.]

Fig. 10. (Right) From Maximilian Armor, Shoe. 1515 to 1525. Magnification, 90 diameters. Etched in picric acid. [See text.]



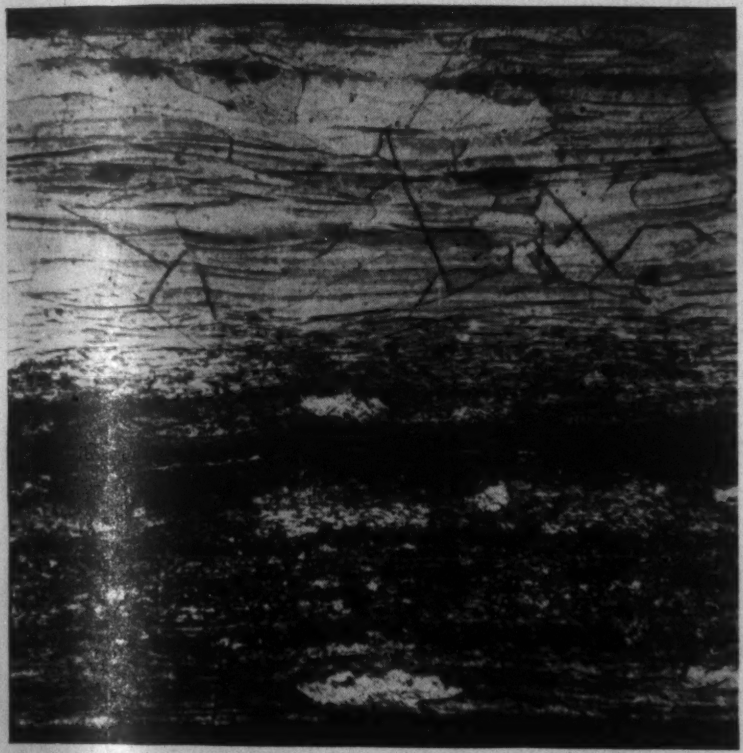
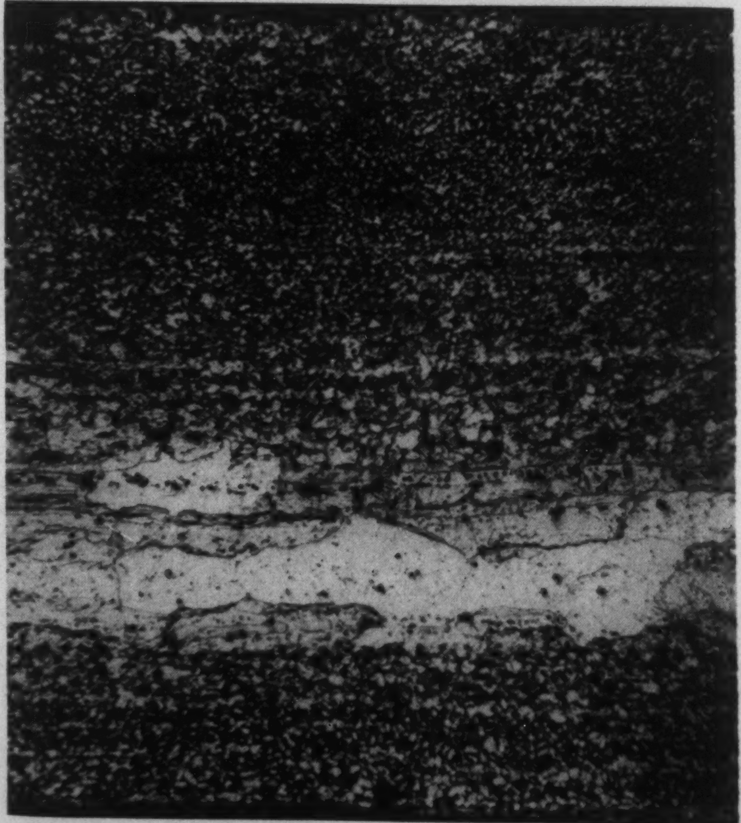


Fig. 11. (Left) — Another area of Fig. 10 Showing Neumann Bands in the Coarse Ferrite (Stead's Brittleness). Magnification, 90 diameters. Etched in picric acid.

Fig. 12. (Right)—From German Armor, Arm Guard. About 1530. Magnification, 90 diameters. Etched in 4 per cent nitric acid. [See text.]



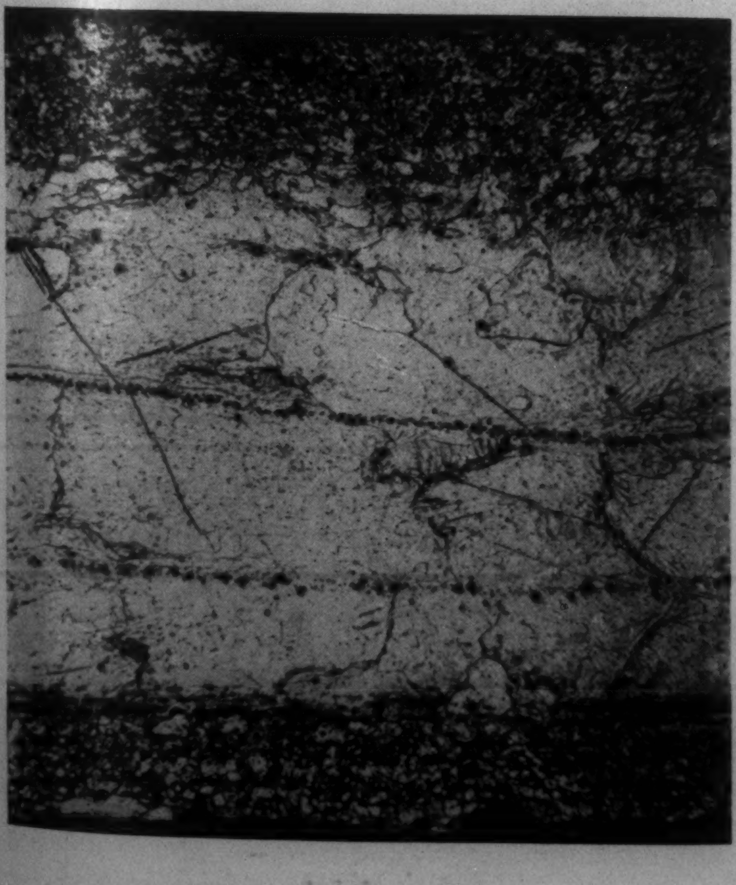
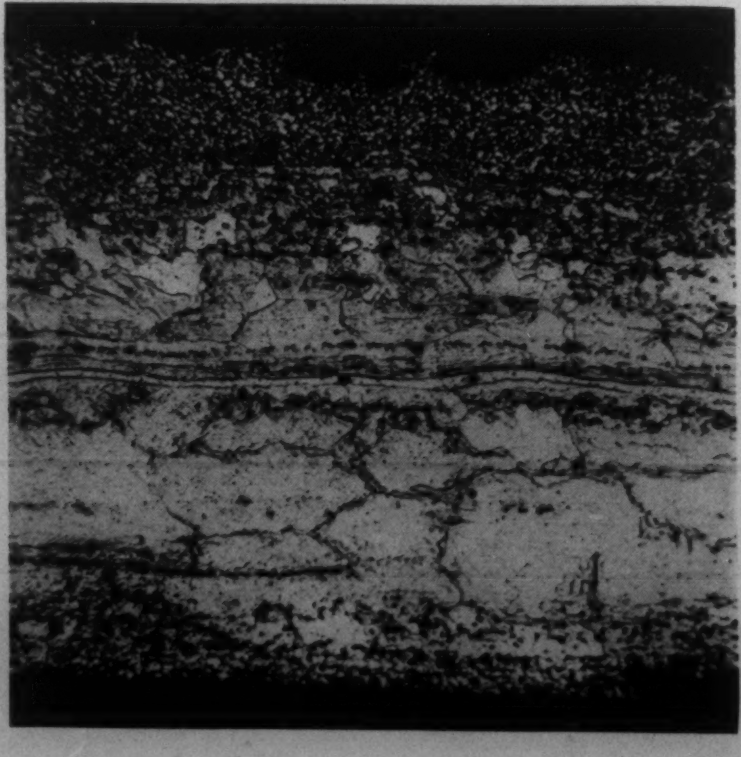


Fig. 13 (Left)—A Second Section (of Fig. 12) with Carburized Surfaces—Much Thinner. Magnification, 90 diameters. Etched in picric acid. [See text.]

Fig. 14. (Right)—A Third Section (of Fig. 12). Somewhat Thinner. Magnification, 90 diameters. Etched in picric acid. [See text.]



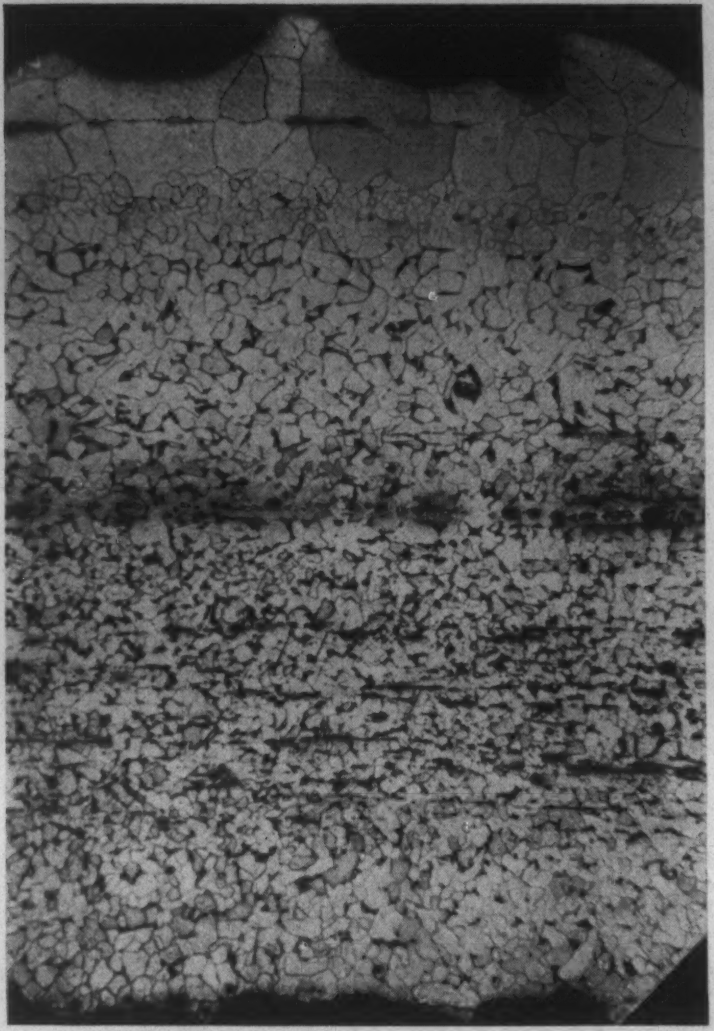
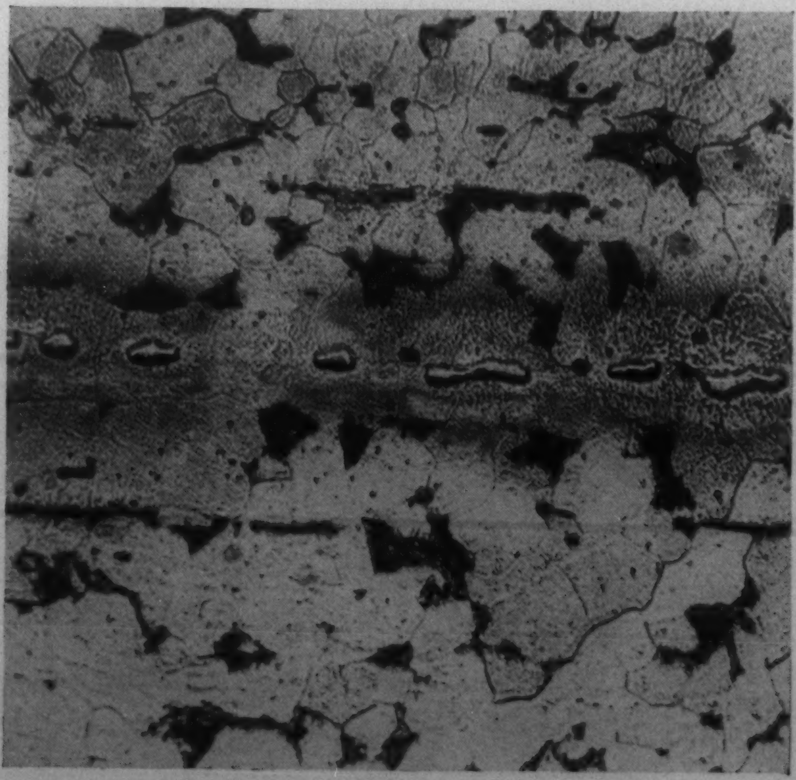


Fig. 15. From English Armor, Part of Shoulder. Probably 1575. Magnification, 90 diameters. Etched in picric acid. Low carbon and fine grained except at the upper surface where we have coarse ferrite alone (Stead's Brittleness). [See text.]

troostite and ferrite dating back to 1460 A.D. Who was the first to produce Stead's Brittleness or abnormal grain growth in steel or iron? I have found it in Greek iron dating back to 400 B.C. Here are samples of armor before 1470 showing it to perfection; and full of Neumann bands! As for "ghosts" due to phosphorus segregation, "banding" due to phosphorus and the like, they are quite common. And as for carbon-free iron that we think of as a new material, we have it here. We haven't any pieces which show nitriding, but that we did find in an iron clamp from the Parthenon about 400 B.C. And why not? Theophilus tells us how to case harden with goose-feathers.

Fig. 16. Magnification, 450 diameters. Etched in picric acid. [See text.]



The following illustrations are all from samples etched with picric acid in alcohol and magnified 90 diameters unless otherwise stated.

Fig. 1—Modern French. 1880 A.D:

Very fine grained ferrite, inclined to be banded with sorbitic pearlite.

Fig. 2—Italian wrist-piece, about 1460:

Carburized wrought iron. Outer surface at top badly rusted, black oxide in pits. Mainly martensite. Inner surface below, ferrite and thin plates of slag, also rusted, passing into a mixture of ferrite, troostite and martensite.

Fig. 3—Same as Fig. 2; 450 diameters:

Lower center—mainly martensite above; ferrite, troostite and martensite below. The coarseness of the structure would indicate quenching from a comparatively high temperature.

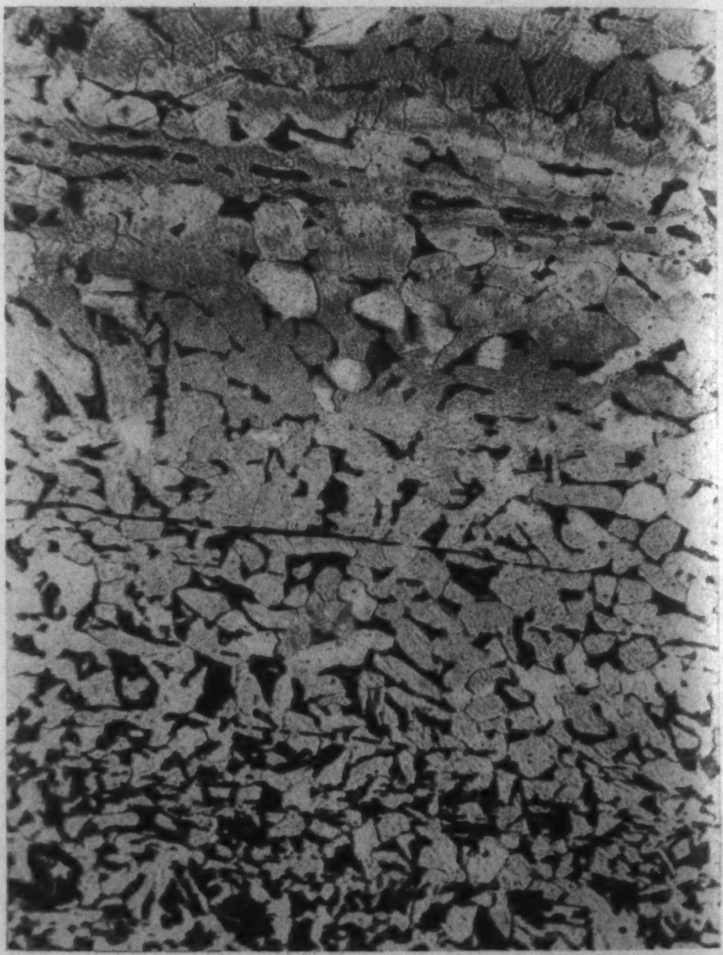


Fig. 17. From English Armor, Leg Piece. 1580 to 1600. Magnification, 250 diameters. Etched in picric acid. [See text.]

Fig. 4—Gothic. Jazeran (Scales on Cloth): Probably Italian—before 1470. 250 diameters.

Carburized but not quenched. Upper part pearlite; center, thin ferrite envelopes. Lower part, ferrite and slag.

Fig. 5—Gothic. Jazeran, also probably Italian—before 1470. Front of body. 90 diameters.

The lower part is comparatively fine grained ferrite and slag. The upper part, carburized, with thin ferrite envelopes surrounding coarse dark-etching grains; probably troostite at surface but sorbitic pearlite in depth. Evidently quenched and drawn well above the blue heat. The coarseness of grain of the carburized surface compared with the soft back is interesting.

Fig. 6—Fragment of Gothic Jazeran. Throat plate. Etched with 4 per cent nitric acid in alcohol:

> Banded. Center of very coarse grained ferrite (Stead's Brittleness). Both surfaces a fine grained mixture of ferrite and pearlite. Such a structure probably produced by a slight amount of hammering followed by a final heating to a red heat.

Fig. 7—Another section showing many Neumann bands in the coarse ferrite. Sample has been subjected to shock.

Fig. 8—Spanish. 1490:

> This is uncarburized wrought iron, full of slag, some of which is in coarse particles which have not flowed under the hammer due to their comparative infusibility at the temperature at which the metal was worked. Such metal is not strong.

Fig. 9—German. Maximilian thigh plate. 1500:

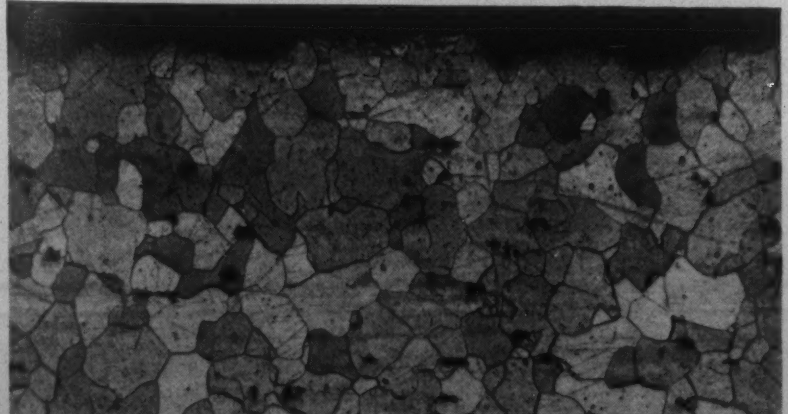
> Laminated, with only a small amount of slag. The carburized layers are martensitic, showing the piece was quenched. Such a structure is characteristic of wrought steel from the charcoal hearth.

Fig. 10—Maximilian, Shoe. 1515-1525:

> Very coarse ferrite on one side, finely laminated on the other, with an occasional coarse grain of ferrite. In the lower part (etched with 4 per cent nitric acid) the carbon is there as sorbitic or even troostitic areas.

Fig. 11—Another area showing Neumann bands in the coarse ferrite (Stead's Brittleness). Near the top of the lower fine grained zone are numerous "cubic" inclusions which might almost be sand grains, unaffected by the forging and polishing in relief.

Fig. 18. From English Armor, Thigh Piece. 1580 to 1600. Wrought iron, free from carbon, all ferrite, with very little slag. [See text.]



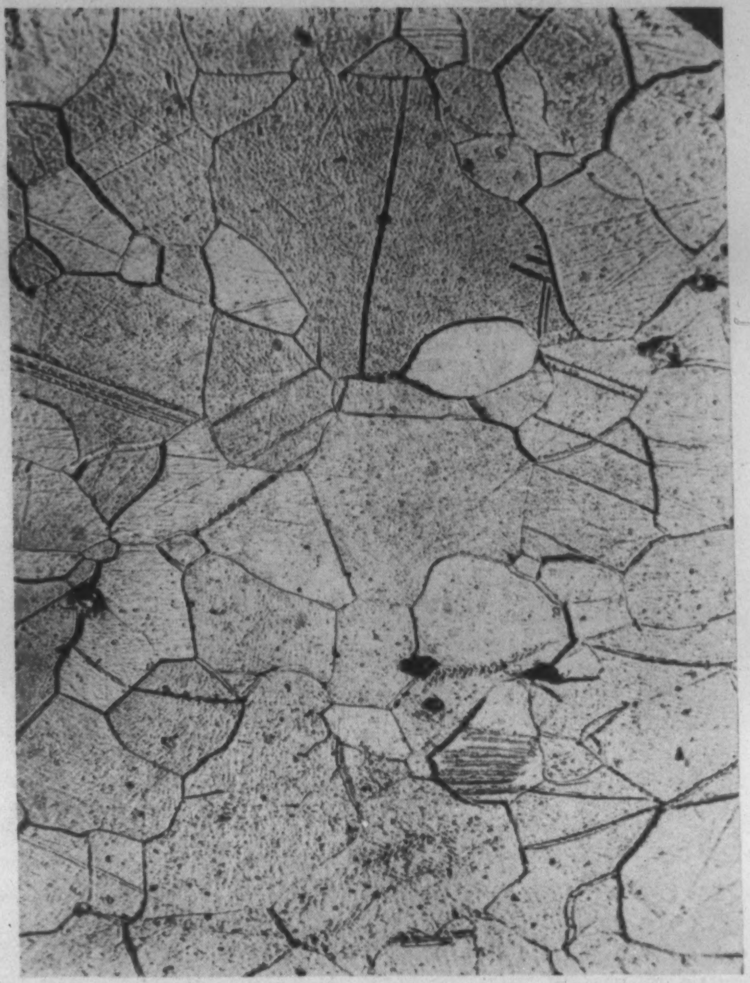


Fig. 19. Another Section (of Fig. 18). Magnification, 250 diameters. Etched in picric acid. Numerous Neumann bands.

Fig. 12—German. Arm guard. 1530. Etched with 4 per cent nitric acid:

> Low carbon upper and lower surface with very fine grain. Central band of very coarse ferrite etching with a curious mottled effect, due to high phosphorus. The metal is comparatively free from slag.

Fig. 13. A second section with carburized surfaces much thinner. The central band of extremely coarse ferrite very mottled due to high phosphorus shows numerous Neumann bands and of course is brittle.

Fig. 14—A third section, somewhat thinner probably due to rusting of the upper surface, which as before is fine grained low-carbon steel. The central band or zone of coarse ferrite shows the mottling due to phosphorus with a well marked "ghost" in the center. Such structures as these are often found in old wrought iron ship-boiler tubes which have been "overheated" in use.

Fig. 15—Part of Shoulder. English. Probably 1575:

> Low carbon and fine grained except at the upper surface where we have coarse ferrite alone (Stead's Brittleness). Not very much slag, but a fine example of "ghost" in the center, due to high phosphorus.

Fig. 16—450 diameters:

> Shows the details of structure of this "ghost" with the typical globules high in phosphorus. In places, the pearlite is beginning to "divorce" into cementite particles.

Fig. 17—Leg-piece. English. 1580 to 1600. 250 diameters:

The upper part shows a typical "ghost", in the center of which are high phosphorus globules. Near the center there are long thin threads of slag. The carbon increases towards the outside and at the surface was about 0.45 per cent (half ferrite and half pearlite).

Fig. 18—Thigh piece. English. 1580 to 1600:

Wrought iron, free from carbon, all ferrite, with very small amount of slag. Near the lower surface is a thin mottled band due to phosphorus segregation.

Fig. 19—250 diameters:

Shows another section with numerous Neumann bands.

From the above examples we have everything structurally from carbon-free iron with only a trace of slag, carbon-free iron full of slag, to well carburized material with a martensitic face and a ferrite back. Numerous cases of abnormal grain growth of ferrite (Stead's Brittleness) are seen, while Neumann bands are not uncommon, and this we should expect in armor always subject to "sudden shock." Lastly, segregation of phosphorus is common both as mottling of the ferrite grains in the very low-carbon material, and as typical ghosts in that containing carbon.

Truly there is nothing new under the sun.

Alas for those fairy tales of the Knight, clad in superb armor which made him immune from every shaft or weapon. The safety lay in the shape and not in the material. The majority of blows would be glancing ones, and harmless, but a direct hit landing perpendicular to the surface would be deadly. The tin hats during the war illustrate this point.

EDITORIAL COMMENT

(Continued from page A 85)

tioning industry will be equally as effective in the recovery from the present one. While this seems doubtful, time will be the arbiter.—E.F.C.

New Metallurgical Publications

WITHIN recent months several new metallurgical publications of various types have appeared. The "Electromet Review" and the "Revere Minute Man" are house organs of the type put out by the Lead Industries, the Copper and Brass Research Association, the Climax Molybdenum Co., International Nickel Co., and others, which, while frankly advertising, are addressed to readers who are, or should be much more concerned about the properties of the materials described than the general public is. These naturally have to be well illustrated to draw attention, and will ordinarily be at least glanced at by the recipient. They offer a rather painless way of getting condensed information written in semi-technical vein into the hands of those who could not grasp detailed technical information, but who may be incited to put their technical men on the track of the details.

A rather elaborate quarterly, "Metal Treatment," has started publication in England, which will deal with both ferrous and non-ferrous metals. Instead of dealing with metallurgy as a whole, as do the A.I.M.E., the A.S.T.M., the A.F.A., and latterly, the A.S.M., in this country, the strong English metallurgical societies have tended to keep ferrous and non-ferrous metallurgy over there in water tight compartments. The publication of "Metallurgia" and now of "Metal Treatment" will help to broaden the viewpoint of the reader.

We have previously discussed the general subject of "the metallurgical needs of the non-metallurgical industries," and the benefit that will come when such industries pay more attention to their metallurgical materials. Some industries do realize how dependent they are on advances in metallurgy, and among these the petroleum industry senses it very strongly. This is evidenced by the establishment of a metallurgical section in the *Oil and Gas Journal,* with T. Holland Nelson as metallurgical editor. This example might well be followed in other industries.—H. W. G.

"Left on Bases"

IN research and development work, lots of good ideas get carried part way toward production and profits but die before they get all the way there.

It is even more unusual for the research man, or the plant man with the idea, to carry it to full fruition himself, than it is for the ball player to knock a home run. Usually after the idea has gotten to first base it has to be advanced further by a larger research appropriation from the management, which may carry it to second. From there on it generally takes the help of some other player, say a plant superintendent, who carries the idea on by introducing manufacturing economies in trial production, or a group who put it through the pilot plant stage, to get it to third. Getting it over the home plate generally requires coordinated team play of a lot of people who are anxious to see the new idea really score and start to bring in profits.

It would be easy to carry the analogy further, but the main point is that no matter how many men are left on bases, only those that finally cross the plate count in the actual score. Too many organizations expect a home run from the man with the original idea and neglect to see that the rest of the batting order wallop the ball in turn.—H. W. G.

IT was an unfortunate error, in the statement preceding the first installment of the correlated abstract on "Progress in Spectrographic Analysis" by T. A. Wright in the September issue, to say that the six papers of the symposium "were not printed" by the American Society for Testing Materials. These papers, with the full discussion, are now offered as a printed pamphlet by the society. This is always the policy of that organization. It is through the courtesy of the society that METALS & ALLOYS is able to present this important and interesting abstract.

Some Metallurgical Aspects of the Radio Tube Industry

By STANTON UMBREIT

Research and Development Laboratory, RCA Radiotron Division, RCA Mfg. Co., Inc., Harrison, N. J.

SINCE THE RADIO receiver has almost become a household necessity, practically everyone is familiar with the radio tubes required for its operation. Very few, however, appreciate the thought and care that has been expended on tube design and construction by the radio engineer, mathematician, chemist, physicist, and metallurgist, most of whose problems are peculiar to the radio tube field.

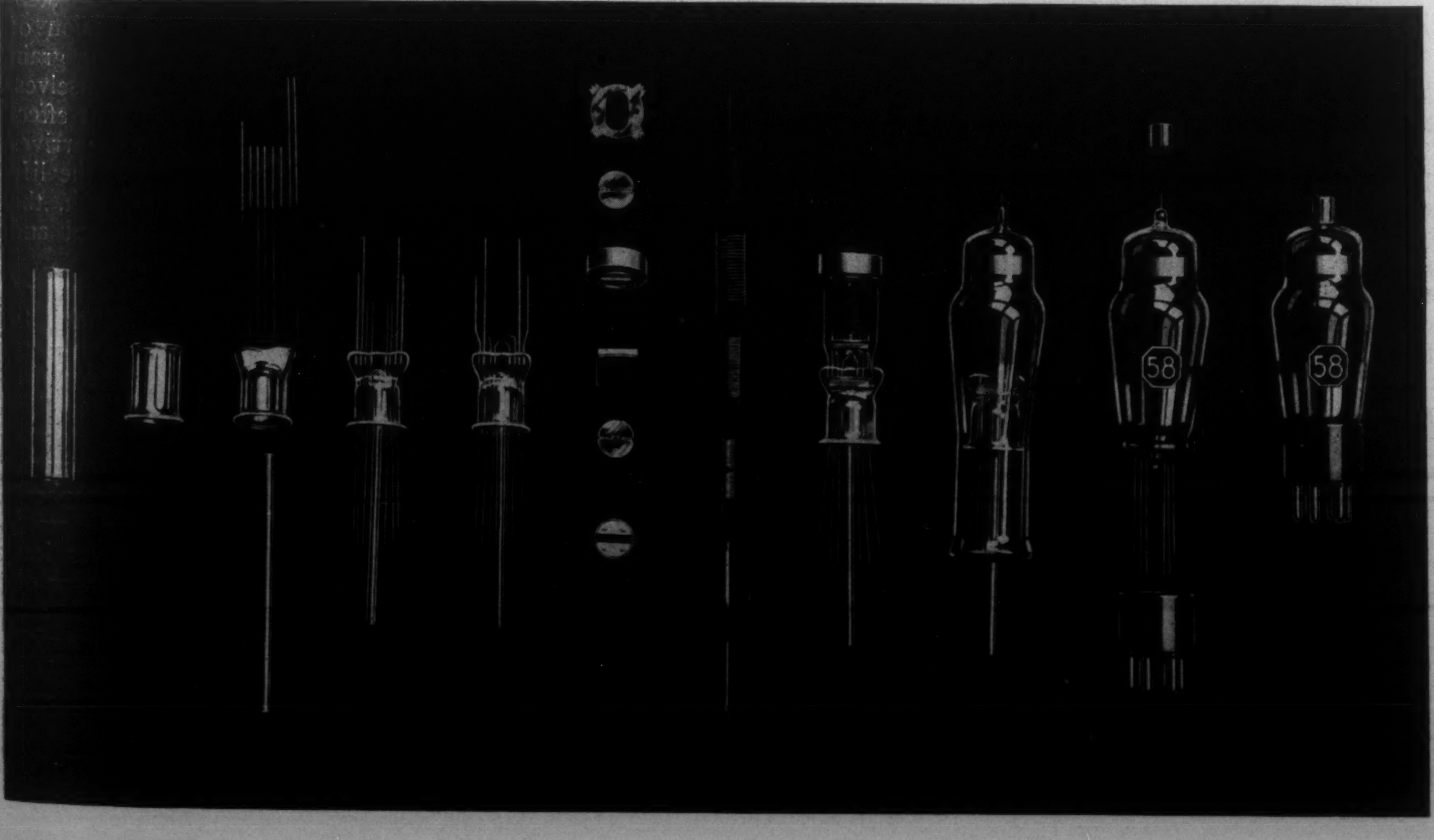
The metallurgist is concerned with the physical properties of some of the rarer metals and alloys, and the chemical or metallurgical reactions occurring at elevated temperatures in high vacuum. Since the action of the radio tube depends upon the flow of current from parts that are heated electrically, many problems relate to the conservation, dissipation, or transference of heat by conduction or radiation. Mechanical properties of filaments at temperatures of 800 to 1800 deg. C may frequently have an important effect upon the performance of the radio tube.

Briefly, the radio tube is a relay for converting minute electrical impulses into much larger ones; it acts by controlling the flow of a large current by means of only a small impulse. The radio tube consists essentially of three elements: The electrically heated cathode which supplies electrons, the plate or anode which by means of its high voltage attracts these electrons and causes a flow of current, and the grid which is placed between the cathode and plate to control the plate current. Because this flow of current does not occur readily in air when moderate voltages are used on the plate, these three elements are surrounded by a container that is exhausted to about one-one hundred millionth of atmospheric pressure.

In the construction of the vacuum tube, the cathode is surrounded by the grid and plate in the form of concentric shells, all of which are usually mounted together on a glass insulator or stem in order to preserve the relative position of the parts. This stem is then sealed into the envelope or bulb which is thoroughly baked and exhausted to remove the gas from all parts. After this operation, the bulb is finally sealed.

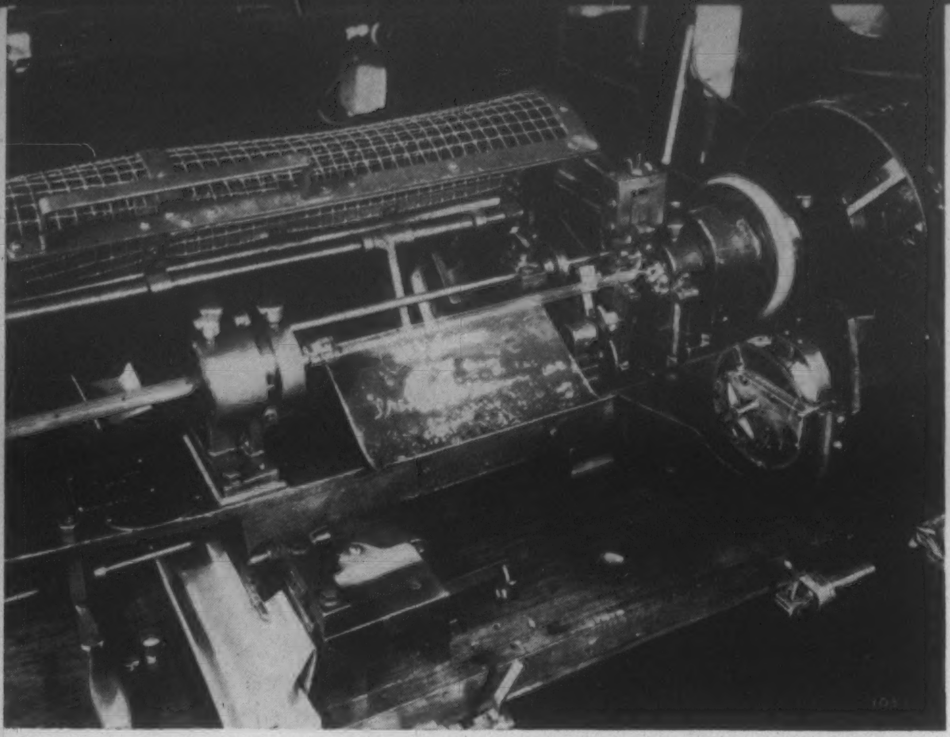
The Cathode the Most Vital Part

Since the operation of radio tubes depends upon the generation of electrons by the cathode, it is the most vital part and accordingly has received the most



Parts and Assembly of Radio Tube. They are, reading from left to right:

(1) Glass flare tubing; (2) flare; (3) electrical connections, mechanical supports and exhaust tubing, ready for sealing into flare; (4) completed stem; (5) stem supports and connections shaped to fit tube parts; (6)—(Top to bottom)—(a) Top mica support, (b) Top shield mica spacer, (c) Top shield, (d) Getter holder with getter; (e) Mica spacer, (f) Bottom shield; (7)—(Top to bottom)—(a) Grid lead, (b) Plate, (c) Suppressor Grid, (d) Screen Grid, (e) Control Grid, (f) Coated cathode sleeve, (g) Heater; (8) Finished mount; (9) mount in bulb ready for sealing; (10) sealed and exhausted tube with grid cap and base; (11) completed tube.



A Lathe for Winding the Grid.

attention from physicists, chemists, and metallurgists. Electrons can be liberated from metals in a number of ways but are most conveniently obtained from hot bodies. The quantity of electrons so produced is determined by the temperature of the cathode and by the nature of the substance used for the cathode. All metals emit more electrons at elevated than at low temperatures, but the nature of the metal is also important since metals differ greatly in their abilities to liberate electrons.

Unfortunately, the best emission is obtained from cathodes made of metals having such low melting points and high vapor pressures that the operating temperatures at which they may be used are limited. The best practical emitter is caesium, barium is next, then thorium and finally tungsten; this series covers almost the entire range of metals as concerns melting point and vapor pressure. Because the emission increases with temperature more rapidly than does the power required to heat the cathodes, they are operated at the maximum temperature permitted by the vapor pressure of the metal in order to obtain the greatest emission for the least expenditure of heating energy. The higher the temperature of the cathode, the shorter is its life, because of the consequent increase in the rate of evaporation of the active material from the cathode.

However, physicists have found that if the active cathode material (caesium, barium, thorium) were applied to the surface of certain other metals, it evaporated less rapidly than it would if the second metal were not there[1]. Apparently, the binding forces between like atoms are less than between certain pairs of unlike atoms. By using coatings of active atoms of certain metals on other metals, it is possible to obtain the high electron emission characteristic of these metals at temperatures even above their normal melting points and also to have greater stiffness in the supporting material. For this reason, caesium is deposited upon silver or tungsten, barium upon nickel or platinum alloys, and thorium upon tungsten.

In order to maintain emission from such a coated surface, it is necessary to maintain the monatomic coating intact against the normal evaporation and the bombardment by ions present in the vacuum and capable of blasting from the base metal the atoms in the active layer. To produce a layer of barium on nickel, the usual practice is to give the latter a heavy coating of a mixture of the oxides of barium and strontium. The reduction of these oxides by contact with nickel at the operating temperature (800 to 900 deg. C) produces a small amount of barium which is sufficient to permit a flow of current between the cathode and anode. This current in turn electrolyzes the barium oxide so that more barium is deposited on the surface of the cathode. In this way, the cathode is self-sustaining since the flow of the electron current maintains the active cathode coating of barium atoms.

Nickel and its alloys, because they are relatively cheap, possess moderate strength at 800-900 deg. C, and are not subject to atmospheric attack as is iron, are generally used for the base of oxide-coated cathodes. Alloys of platinum, to a greater extent formerly than now, are used for tubes requiring a very long life (50,000 hrs.) and where the first cost is relatively unimportant. Since the presence of impurities in the base of the oxide-coated cathode is important, the base metal must be obtainable either in a relatively pure state or with the impurities capable of close control.

Thoriated-Tungsten Cathodes

Thorium-coated tungsten cathodes are obtained by incorporating a small amount of thorium oxide in the tungsten powder during the process of manufacture of the tungsten wire. Cathodes of this wire are activated by heating them briefly to about 2300 to 2500 deg. C; at this temperature, some metallic thorium is produced by the reaction between the thorium oxide and the tungsten. A longer period of heating at 1750 to 2050 deg. C then permits the thorium to diffuse to the surface of the cathode and to cover it with the active thorium atoms.

Ordinarily such filaments are operated at 1550 to 1750 deg. C where the rate of production of thorium and its rate of diffusion to the surface are low; the maintenance of the active surface against bombardment and evaporation is accomplished by the diffusion of thorium to the surface. Under proper operating conditions, a small amount of metallic thorium is always present in the cathode and diffusing toward the surface. Since thorium evaporates more rapidly from a thorium surface than from a tungsten surface, thorium atoms in excess of that required to maintain a layer one atom thick on the surface of the tungsten, are rapidly lost by evaporation. Since diffusion of thorium to the cathode surface occurs along grain boundaries rather than through the grains themselves, the grain size of the cathode has an important effect on the life of the thorium layer. If thorium arrives at the surface too rapidly, it evaporates and the life of the cathode is short; if not rapidly enough, the monatomic layer of thorium is not maintained and the election emission drops.

The relatively high thorium concentrations of thorium-tungsten alloys permit the thorium to evaporate as readily from the cathode as from pure thorium so that the life of the cathode is short. For this reason, alloys of tungsten and thorium, besides being expensive and difficult to prepare, are not as satisfactory as thoria-tungsten mixtures. However, in either case, if the cathode is heated in an atmosphere of hydrocarbon, a layer of tungsten carbide is formed on the surface from which thorium evaporates less rapidly than from tungsten. Furthermore, because of the larger grain size of the tungsten carbide, there are fewer grain boundaries to feed the cathode surface with thorium atoms; thorium reaches the surface less rapidly, evaporation from the surface is reduced, and the life prolonged.

The use of very high plate potentials in transmitting tubes results in such severe bombardment by gaseous ions that thorium cannot remain long on the cathode surface. For such tubes, cathodes are designed to operate with the normal emission from pure tungsten, even though this material requires a higher temperature and gives poorer efficiency.

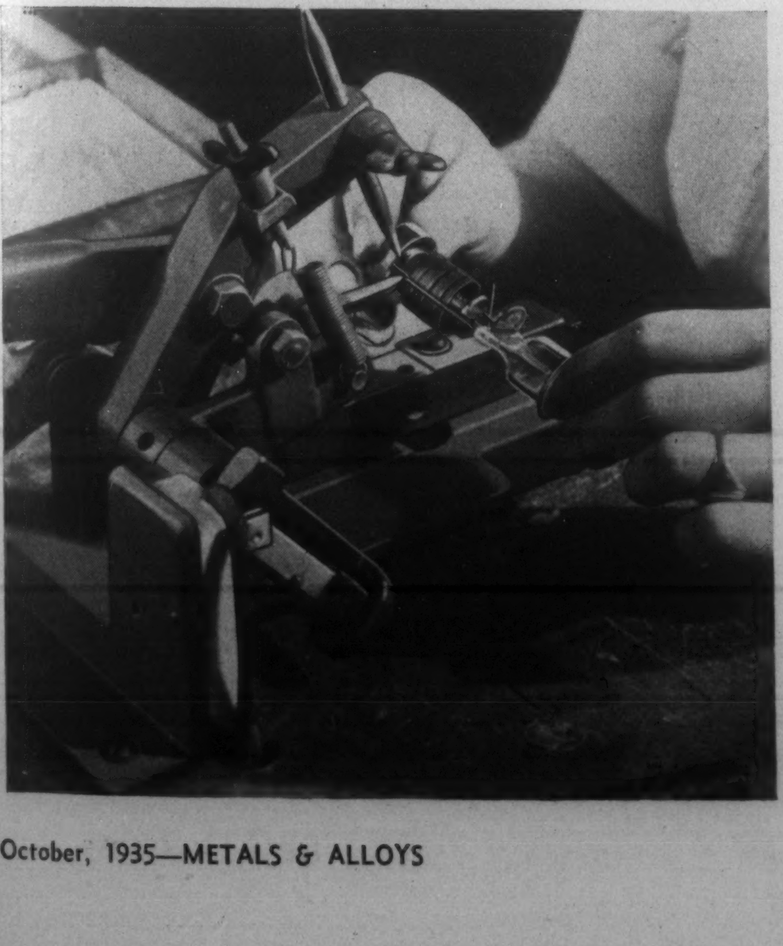
Properties of a Metal for Cathodes

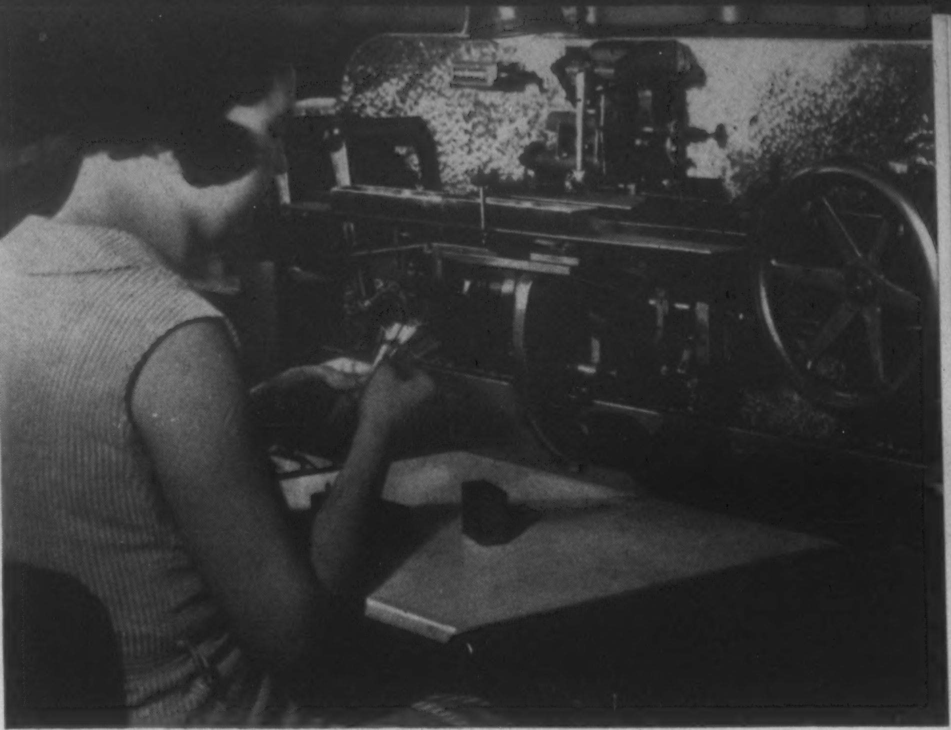
The properties desired in a metal to be used for a cathode are, first of all, an inherent ability to emit electrons relatively easily at any temperature, or as the physicist expresses it, it must possess a low "work function"; next, it must have a low vapor pressure, a low thermal emissivity, and a high melting point so that the operating temperature may be made high in order that the electron current may be produced with a relatively small expenditure of energy; a low thermal conductivity so that less heat is conducted away along the cathode to the supports; a high tensile strength and stiffness at elevated temperatures so that the cathode will retain its shape and position with respect to other elements.

In the construction of cathodes, some of the deficiencies of the present metals are compensated for in the design of the filament used as the cathode. For instance, the operating temperature of filament-cathodes is usually determined, not by changing the electrical resistivity or thermal emissivity of the material but by increasing the superficial area by rolling the wire into a ribbon. This has a further advantage in that when a coating of oxides of barium and strontium is to be applied to the filament, it is accomplished more uniformly on flat ribbon than on round wire. In other types, the filament may be coiled or crimped in order to reduce the heating power required.

In order to reduce or prevent the small displacements of the filament with respect to the grid which give rise to "microphonic"[2] noises, it is customary to use considerable tension on the filament so as to keep it taut even at the operating temperature. If the tension is too great, the life of the filament is short because it fails by creep. In order to avoid this premature failure, alloys of nickel with silicon, cobalt, iron, or titanium have been substituted for pure nickel; likewise, platinum alloys containing nickel, cobalt, rhodium, or iridium have replaced pure platinum.

Mounting of Parts of a Tube by Welding.





The Making of Three-Piece Lead-in Wire. This lead consists of lengths of copper, dumet, and nickel wires butt-welded together in order.

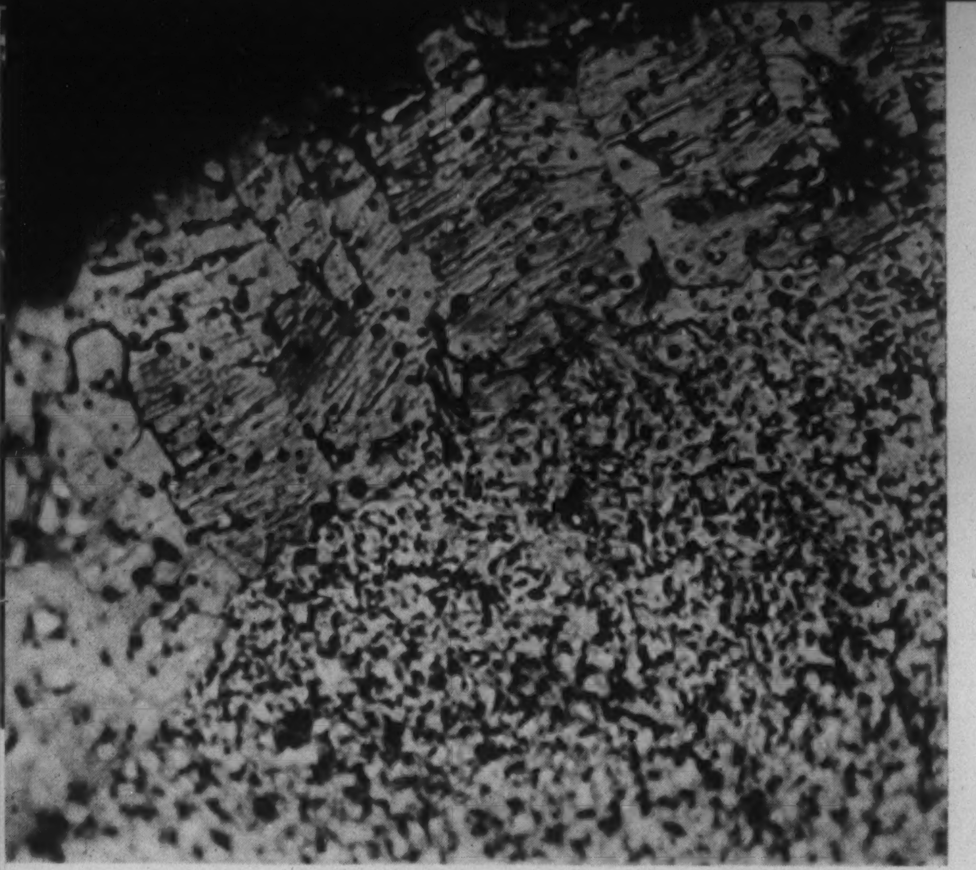
With the advent of radio sets operated entirely by alternating current power, it became necessary to insulate the cathode circuit from its heating circuit in order to prevent hum and interfering noises. This was done by using a heater of tungsten inserted in a tubular coated cathode of nickel. The heater and cathode are separated by an insulator of magnesia, alumina, or beryllia having high electrical resistivity at temperatures of 1200 to 1400 deg. C because, although the temperature of the cathode remains at 800 to 900 deg. C, the temperature of the heater is considerably higher. Tungsten is preferred as a heater material because it has the requisite hot strength and melting point.

Function of the Anode

The function of the plate or anode is the collection of electrons and the dissipation of heat. The anode should not act as a source of electrons and, therefore, should remain as cool as possible in spite of the energy developed on its surface by the impact of high speed electrons. When the power output of the tube is low, the anode may be made of nickel or iron strip. But because the dissipation of heat from a bright metal surface is low, the nickel strip is usually given a coating of amorphous and graphitic carbon. This carbon coating is applied by heating the metal in an atmosphere of hydrocarbon vapor or gas so that it is decomposed with the deposition of carbon on the surface of the metal.

The character of the carbon deposit is determined largely by the temperature used for the decomposition of the vapor; if the temperature is too low, the deposit is sooty and contains too much gas which may be liberated slowly during the life of the tube; if the temperature is too high, the deposit is more graphitic in nature and not such a good radiator. Because the temperature used for the deposition of carbon is usually high enough to carburize iron, nickel is generally used for parts that are carbonized. The use of coatings of the dark oxides of nickel, iron, chromium, etc., on the plate for increasing the radiating ability has not been successful, due to the decomposition of these oxides at the low pressure and high temperature attained either in the manufacture or in the operation of the tube.

Where plate voltages are high, the liberation of gas is serious, so that such carbon deposits are not used. Molybdenum, because it contains little gas and possesses sufficient ductility to permit forming into simple



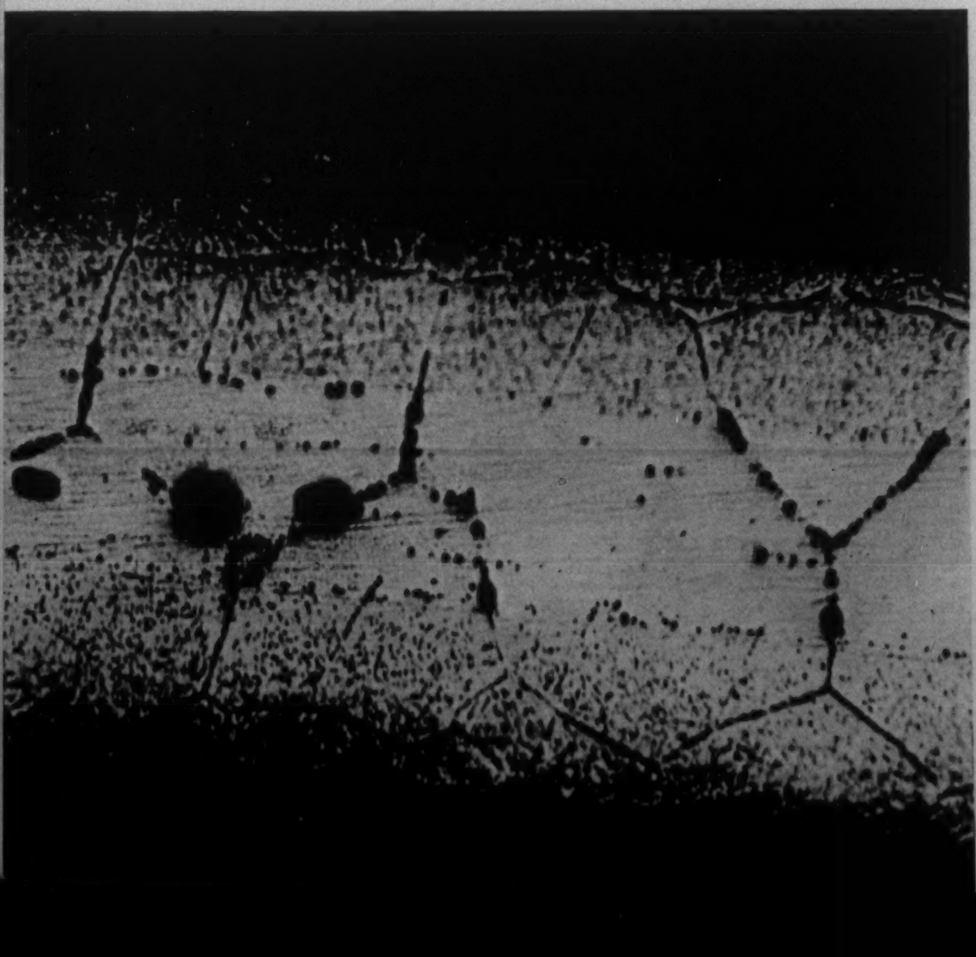
Portion of a Cross Section of a Carburized Thoriated-Tungsten Filament. The coarsely crystalline material is W_2C, the dark particles are ThO_2. Magnification, 2,000 diameters.

structures, is used for plates in spite of its poor radiating ability which, however, can be improved slightly by sand-blasting the surface. Because of the limited ductility of molybdenum and the expense of rolling it into strip, plates of this material have only limited use. Recently, rigid plates having rather heavy sections have been cut from graphite, a material which is cheap and an excellent radiator; the porous nature and the high gas content of graphite require that these plates be given a treatment to extract the gas.

In common with other electrical devices, the output of a transmitter tube is limited by its ability to dissipate heat and by the permissible rise in temperature. In order to improve the output, large tubes are made with water-cooled copper shells, which act as both anode and part of the envelope. Copper is used for this purpose because its great ductility permits the drawing of deep cans, because it has high thermal conductivity, and also because a vacuum-tight seal can be made between it and glass.

The grid or grids are placed between the anode and cathode and control the flow of current between them. Since the shape and position of the grid relative to the other elements is very important, it is necessary that the grid, which is composed of fine wires, supported by one or more heavier wires, shall not distort during the process of manufacture.

Longitudinal Section of Nickel Strip Embrittled by the Absorption of Carbon. Magnification, 500 diameters.



Materials for the Wire in Grids

The qualifications desired in materials to be used for the fine wires of the grid are: Low thermal expansivity in order to avoid buckling caused by heating during the exhaust process; small drop in elastic limit when heated to 1000 deg. C so that it will not be permanently deformed by the magnetic forces caused by high-frequency heating during exhaust; sufficient cold ductility to permit ready forming into shape, and poor inherent ability to emit electrons (high work function). The last, because often the grid is placed so very close to the heated cathode that it is heated by radiation and may also receive a deposit of active cathode matter permitting the grid to act as another cathode.

Molybdenum has most of the desirable properties such as low coefficient of expansion, high hot strength and stiffness, ductility, high thermal conductivity, and one other property which has not been mentioned, namely, reducibility of the oxides by hydrogen. Since cleanliness is absolutely essential in the manufacture of radio tubes, it is customary to clean all metal and nonmetallic parts, except glass, that are within the bulb, by heating in hydrogen. Commercial hydrogen contains small amounts of oxygen and water vapor which produce irreducible oxides on the surface of alloys containing chromium, aluminum, manganese, etc. On account of its high cost, substitutes have been used for molybdenum with sacrifice of some of the desirable properties. By changes in design and construction, it is possible to use alloys of chromium, iron, or manganese with nickel, or an alloy of iron, nickel, and molybdenum.

The grid is helically wound by laying a fine molybdenum (or its substitute) wire in grooves cut in larger support wires, usually of nickel, and then peening the metal over the wire to hold it in place. The support wires should be of metal sufficiently ductile to permit cutting and peening of the grooves, of good thermal conductivity so that radiant heat received by the grid is conducted away fast enough to maintain a low grid temperature, and of good reflectivity so that little radiant energy is absorbed.

For side supports, pure nickel, low in hardening constituents, such as carbon, and especially annealed and treated to give softness, is generally used. Iron is not so good due to mechanical properties that prevent good cutting and peening. Copper is used where high thermal conductivity is essential but, because of its poor welding properties, its use is greatly limited. What is needed is a soft, ductile metal of good thermal conductivity. The requirement of weldability is very important since only by welding the parts together can rigidity and good electrical contact be obtained. Without welding, it would be impractical to assemble the intricate structure of the complex tubes containing a half dozen or more elements.

Materials in the Envelope or Bulb

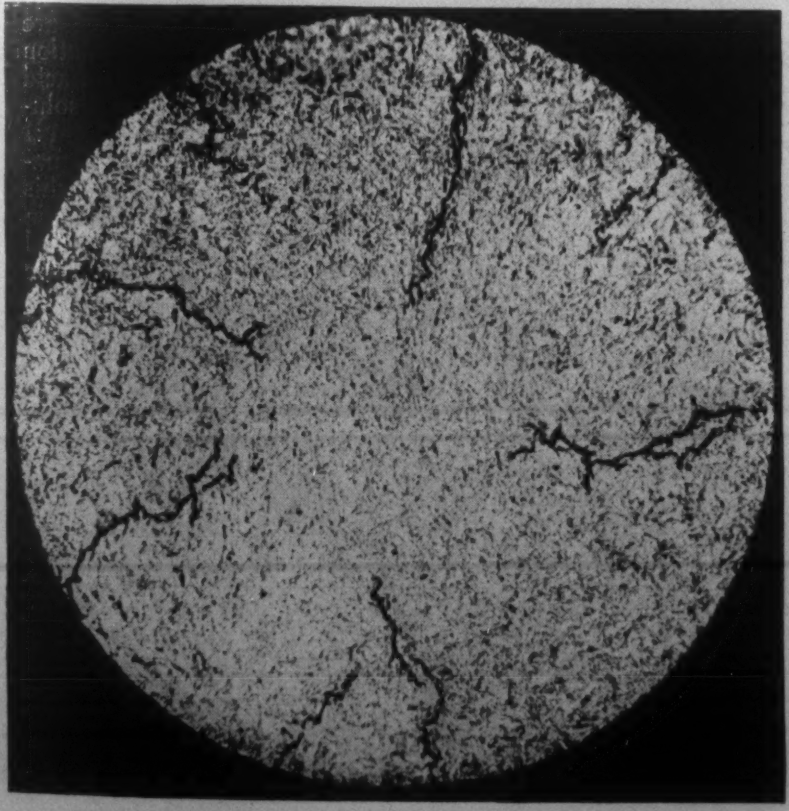
The envelope or bulb serves to surround the functioning elements with a permanent high vacuum; in smaller tubes, the envelope is entirely of glass, in transmitting tubes, most of the glass is replaced by copper which then becomes the anode and permits the better cooling mentioned previously. To make a vacuum-tight seal at the point where the leads enter the bulb, it was formerly the practice to use platinum for the conductors imbedded in the so called soft glass. Although the thermal expansion of platinum approximates that of glass, the prohibitive cost has led to the use of other materials.

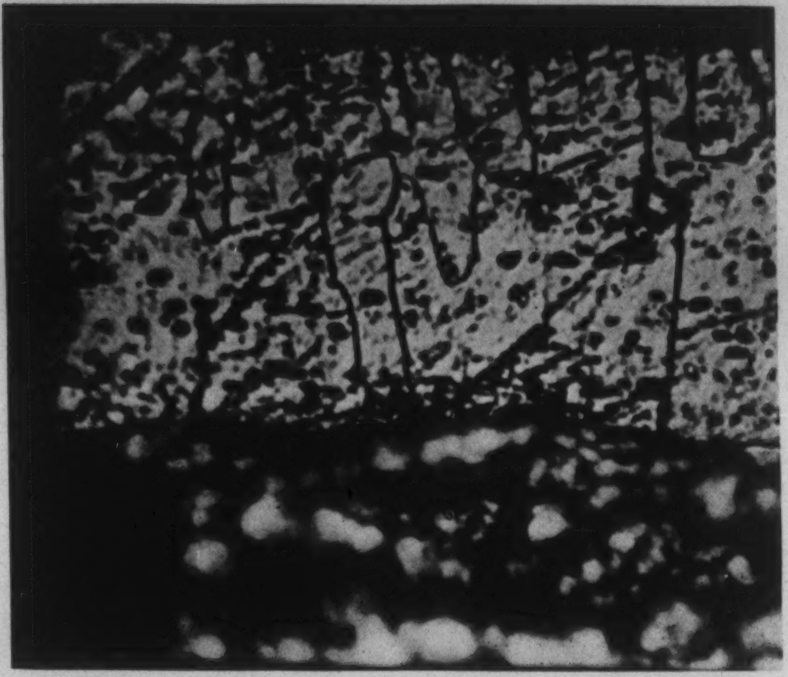
A duplex wire consisting of a core of 42 per cent nickel steel surrounded by a layer of copper[3], whose thickness is so chosen that the composite expansion is slightly less than that of glass, is now being used almost exclusively with soft glass. The copper surface is particularly useful because the oxide of copper, formed during the process of making a joint to glass, is soluble in the glass; this permits the plastic glass to wet the copper and produce a tight seal. While this duplex wire has been used for many years without any changes, it has several disadvantages that might be removed. Since it is a composite wire, the cost of manufacture is relatively high and, furthermore, the thermal expansions, radially and longitudinally, are different. This difference is not so important where seals into glass are made with fine wires, but large seals can not be made because the expansion of the glass and the "dumet" wire, as it is called, can not be matched in all directions.

The electrical conductivity is comparatively low due to the relatively small amount of copper used. Because of their high electrical resistivity and because glass does not readily wet them, ferrochrome or ferro-nickel alloys, uncovered with copper, are used to a very limited extent although their average expansivities can be made to approximate that of glass. For seals into "hard" or borosilicate glass, such as is used in the larger transmitter tubes, tungsten is being used although it is expensive, brittle at room temperature, and requires special preparation in making the seal. Cobalt-nickel-iron alloys, the expansivity of which closely matches that of the glass over the range between the strain point of glass and room temperature, will probably come into use for both hard and soft glasses.

The bulb or envelope is heated thoroughly during the exhaust process in order to remove moisture "vapors" and gases from the glass and metal parts, after which it is sealed off or closed. With the high-speed exhaust schedules in use at the present time, the vacuum is much too poor to permit satisfactory electron emission. Even an excellent vacuum, produced by careful exhaust conditions might not persist because of the seepage of gas from the metal and glass parts. So, to produce and retain a satisfactory vacuum, a metal which will react or combine with the gases present is deposited on the inner surface of the bulb. This metal or "getter," as it is called, has sufficiently volatility to permit sublimation onto the inner surface of the bulb where the exposed surface is great and where it can adsorb or unite chemically with such gases as oxygen, water vapor, nitrogen, hydrogen, carbon monoxide, or carbon dioxide.

Cross Section of Over-Worked Tungsten Rod, Used as a Seal-in-Glass. This seal was not vacuum-tight. Magnification, 80 diameters.





Longitudinal Section of a Carburized Thoriated-Tungsten Filament. The crystalline material is W_2C and contains strings of beads of ThO_2. Magnification, 2,000 diameters.

Use of Magnesium and Barium

The metals of the alkaline earth group seem most satisfactory since they possess sufficient volatility and affinity for gases without being too easily attacked by atmospheric moisture. Magnesium and barium are most widely used either singly or as an alloy. Magnesium, because of its greater volatility and stability to atmospheric exposure, is the base of the getter to which barium is added because of its greater affinity for nitrogen and hydrogen. Calcium, strontium, aluminum, and cerium have been used for special and limited cases; the alkali metals might be used but for their susceptibility to atmospheric corrosion and their high vapor pressures. The presence of a vapor pressure of the getter metal greater than 10^{-5} to 10^{-6} mm of mercury at 100 to 200 deg. C would interfere with the operation of the tube. In a tube having an active coating on the cathode, the higher the plate voltage, the lower must be the gas pressure (and the vapor pressure of the getter) in order to avoid the damage or destruction of the active coating by bombardment with ionized gases.

Metals having unusual characteristics, either high or low values, of the following properties might find application in the radio field: Electrical resistivity and its temperature coefficient, thermal conductivity, thermal emissivity or radiating power, thermal expansion, vapor pressure both of the metals and their oxides, ductility, stiffness and tensile strength both at room and elevated temperature, magnetic permeability. Per-

(Continued on page 279)

Rapid Determination of Nickel in 18 and 8 and Other High Chromium Steels and Alloys

By FRED P. PETERS

Chemist, The Wilbur B. Driver Co., Newark, N. J.

THE RAPID DETERMINATION of nickel in corrosion resistant, heat resistant and electrical resistance alloys has always been somewhat of a problem. The increasing interest in the applications and properties of such alloys is, in addition, bringing the analytical chemist more and more into contact with them, often under conditions which necessitate rapid as well as accurate execution of the analyses. The method which is herein described offers the analyst a convenient means of determining nickel in the presence of any amount of chromium, with the utmost rapidity, and with precision only slightly less than that of the best umpire method. The method, originally developed for the routine analysis of nickel-chromium electrical resistance alloys, has been found to be of distinct advantage for the determination of nickel in steels of the 18 and 8 type as well.

This article describes specifically the application of the method to the determination of this element in 18% chromium, 8% nickel steels.

The most exact methods available for the determination of nickel in such steels are based on the precipitation of nickel as nickel dimethyl glyoxime.[1,2] The precipitation is not subject to interference or contamination by other metals ordinarily present in the alloy, as under the proper conditions neither cobalt,[3,4] copper, iron, manganese nor chromium will interfere. An electrolytic extension of the dimethyl glyoxime method provides even more precise results for any case.[5,9]

Both the gravimetric dimethyl glyoxime method and its electrolytic extension are time consuming, however, and, where extreme accuracy is not an essential, a more rapid method would be far more satisfactory. With chromium-free steels volumetric methods based on direct titration with silver nitrate and potassium cyanide[10] have been found entirely suitable, but with 18 and 8 and similar alloys, titration of the neutralized sulphuric acid solution of the alloy cannot be made directly, as trivalent chromium, when present in such large amounts, imparts an indescribably somber green color to the ammoniacal citrate solutions usually employed. The deep gloom is so heavy in most cases as to prevent exact location of the endpoint, which in this titration is the appearance of a faint turbidity of silver iodide. Only with a brilliant source of side illumination is it possible accurately to locate the endpont in cyanide titrations of solutions containing much trivalent chromium.

To circumvent this difficulty, the nickel may be separated with dimethyl glyoxime before performing the titration[6] or the chromium may be oxidized to the hexavalent state (to brighten the solution) with a slight excess of $KMnO_4$ in hot solution, and the precipitated manganese dioxide filtered off before continuing.[7]

Each of these preparatory procedures, however, includes a filtering operation, which not only slows up the determination, but may affect the accuracy because of possible losses from incomplete washing. In the method to be described, the chromium in acid solution is oxidized to the hexavalent state by evaporating with perchloric acid, and the cyanide titration performed directly, after diluting and neutralizing the free acid. No filtration is required, the oxidation of the chromium need not be 100 per cent, and it is not necessary to boil out free chlorine as with chromium and/or vanadium determinations. The color change at neutralization is sharp and distinct (from chromate yellow to deep green), and the endpoint of the titration itself is readily and accurately distinguishable, as the lemon yellow color of the hexavalent chromium in the solution is sufficiently bright to make possible easy observation of all changes within it without auxiliary illumination.

The method as it has been adapted to 18 and 8 steels is as follows:

An 0.50 gram sample of the steel is dissolved in diluted aqua regia, (30 parts HCl, 10 parts HNO_3, 40 parts H_2O), and evaporated nearly to dryness. 20 ml of perchloric acid, (70%, technical grade) are added, and evaporation is continued until fumes of $HClO_4$ are evolved, and the solution assumes an orange-red coloration. The beaker is removed from the heat, allowed to cool for 2 min., the cover and walls washed with a jet of hot water, and the solution stirred to dissolve the salts. The volume of solution is then brought to 150 ml with cold water, and 10 ml of 1:1 H_2SO_4 are added, followed by 10 ml of ammonium citrate solution (1 liter of solution containing 454 grams of citric acid approximately neutralized with ammonia). The solution is then neutralized by adding, dropwise, 1:1 NH_4OH, until the solution assumes a full-depth aquamarine color, and then 10 drops in excess. At this point the solution should smell *faintly* of ammonia after blowing the fumes away from above the liquid in the beaker. 3 ml of 1 normal potassium iodide are added and the solution allowed to cool somewhat.

From a burette are added exactly 2 ml of standard silver nitrate solution, (2.925 grams per 500 ml) and the cloud of silver iodide so formed in the solution is then removed by titrating with standard potassium cyanide solution (15 grams KCN and 5 grams KOH per 2 liters of solution) to crystal clarity. The clear bright, orange to yellow solution is now back-titrated with the silver nitrate solution until a faint opalescence is obtained. The total volume of each standard solution used is recorded, and the nickel content is calculated as follows:

$$\text{Per cent Nickel} = \frac{(\text{Volume KCN} - \text{Volume AgNO}_3 \times \text{F}) \times \text{Nickel titre KCN} \times 100}{\text{Wt. of Sample}}$$

"F" is the cyanide equivalent of one ml of the silver nitrate solution, and is found by adding 5 ml of the cyanide to a solution that has just been titrated completely, and then titrating with the silver nitrate until the slight cloudiness just reappears. "F" will therefore be 5 divided by the number of ml of silver nitrate used in this operation, and with the strengths of solution specified should approximate 0.65 ml KCN for one ml $AgNO_3$.

The nickel titre of the KCN solution may be obtained by dissolving in dilute nitric acid 2 grams of high purity nickel, fuming with 20 ml of perchloric acid, diluting to exactly one liter, and analyzing 50 ml of this solution electrolytically for nickel plus cobalt. 25 ml of this standard nickel solution are then extracted with a pipette, diluted to 150 ml, and a saturated solution of nickel-free potassium dichromate crystals in water added dropwise to match approximately the yellow color of the alloy solutions just before treatment with ammonium citrate and neutralization. The standard is now treated with citric acid, neutralized, and titrated with cyanide and silver nitrate exactly as in the determination proper. From the known nickel content per ml of the standard solution, and the cyanide volume (after deducting the silver nitrate volume times "F") required to react with 25 ml of it, the nickel titre of the cyanide solution is readily calculated. A standard cyanide solution of the strength specified should have a nickel equivalent of about 0.0015 gm per ml. The cyanide solution should be standardized, and the cyanide-silver nitrate relation (F) obtained once every three or four days, as the cyanide will be found to diminish in nickel equivalent at the rate of about 0.01 milligram nickel per week.

Solutions containing citric acid should be neutralized as soon as possible to prevent reduction of the chromate, which occurs if, for example, such acid solutions are allowed to remain overnight before neutralization and titration. Also there should be avoided an undue excess of free NH_4OH in the solution at the titrating point, as low results may thus be obtained. Conversely, insufficient amounts of this reagent will tend to produce high results.[8]

The amount of perchloric acid used should be held to the minimum required to oxidize most of the chromium to the hexavalent state and still maintain a liquid residue. The author's experience has been that, if a large excess of $HClO_4$ is added, a crystalline precipitate of ammonium perchlorate will form during addition of the cyanide in the titration, and practically ruin the determination. No trouble from this source will be encountered, however, so long as the amount of perchloric acid used is never allowed to exceed 25 ml.

The small amounts of silica which may be seen floating in the solution need not be removed, since the flocculent nature of this precipitate obviates any possibility of interference with the endpoint.

Interfering elements are those which react with cyanide in a manner similar to nickel. A discussion of their action may be found in any good textbook on steel analysis, but it should be stated here that their effect is normally of no importance, as copper and cobalt, the most likely interfering elements, are seldom present as major constituents of such steels as we are discussing. Cobalt, in negligible amounts, is almost always present in high nickel alloys, and may be included in the nickel percentage without seriously affecting the analysis, except in the most exact work, in which case a cyanide titration probably would not be used.

Results by this perchloric acid-cyanide method have been found to be of an excellent order of accuracy. Nickel determinations performed by this method on Bureau of Standards Sample No. 101, an 18 per cent chromium, 8 per cent nickel steel containing 8.44 per cent nickel, have checked this value between 8.38 and 8.44 per cent on various occasions, with much the greater majority of such checks falling between 8.42 and 8.44.

The usual and obvious precautions must be observed when handling cyanide solutions. Perchloric acid, on the other hand, offers no explosion hazard whatsoever if cold and/or dilute, and even if hot and concentrated in the absence of oxidizable organic matter. No difficultly soluble metal salts are formed, and there is no violent evolution of heat on diluting the concentrated acid with water, as with sulphuric acid.

For the analysis of materials containing more nickel than that present in 18 and 8, proportionately smaller amounts of sample should be taken, and stronger cyanide solutions used. For example, the analysis of "Tophet A," an 80 per cent nickel, 20 per cent chromium alloy, is performed using an 0.25 gram sample for the nickel determination, and a standard cyanide solution three times as strong as the solution previously specified.

It may be of interest to note that Lundell, Hoffman and Bright[11] have suggested a procedure for nickel-chromium steels, that includes the use of perchloric acid and of a direct cyanide titration. In their method, however, the perchloric acid is added to oxidize the chromium for the *chromium* determination, the chromium is titrated with ferrous ammonium sulphate, and the nickel is then titrated, in the presence of the trivalent chromium, with potassium cyanide and silver nitrate. It will be recognized at once that this procedure, in which the perchloric acid is incidental and not essential to the nickel determination, is not the same as that outlined in this article. The important feature of the perchloric acid-cyanide method for nickel is that the chromium has been conveniently converted to the hexavalent state to facilitate titration of the nickel.

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(Continued from page 277)

haps, more information concerning the properties of the metals and alloys now available would be as useful as the development of new alloys. The metallurgical physicist might furnish more data on thermal and electrical properties of metals and alloys at temperatures up to 800 or 1000 deg. C; the data on this region are meager. The study of the solution of gases by metals and the mechanism of the diffusion of gases through metals is beginning to attract the attention of metallurgists and should yield profitable results.

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[1] This is only possible because the electrons are removed from the atoms on the surface layer which need be only one atom thick, and as long as this monatomic layer is maintained, the normal emission remains. Losses by evaporation must be replaced by fresh atoms.

[2] Some note that the loud speaker of the radio receiver produces in the grid or filament of a "microphonic" tube, a sympathetic vibration, which is amplified and reproduced in the speaker. The result is a howl of increasing intensity

[3] The copper is usually about 25 per cent of the total.

Phosphorus as an Alloying Element in Steel—I

A Correlated Abstract

By H. W. GILLETT

CONSUMERS AND PRODUCERS of steel are showing great interest in cheap, high-yield-strength, low-alloy steels for such uses as railroad car construction and general structural purposes where design is on a yield-strength basis and weight savings can be made. In many such uses resistance to atmospheric corrosion is an important factor.

To formulate suitable steels for such purposes, the cheap alloying elements, copper, chromium, manganese and silicon, as well as some of the more expensive ones like nickel and molybdenum, are being put together in a variety of combinations. Some of these are being commercialized, but engineering practice has not yet settled upon any single one as standard, nor is full standardization likely to occur since one combination may have a shade the better of another for a particular use, and since, with variations in cost of alloying elements, it is well worthwhile to have at hand different ways of securing equivalent properties.

This state of affairs is also met in Germany, where the old carbon structural steel "Stahl 37" (52,500 lb. per sq. in. tensile strength specified) is meeting considerable replacement by "Stahl 52" (74,000 lb. per sq. in. tensile strength specified). "Stahl 52" is a class designation, and, so long as he can meet the specification as to properties, the manufacturer may use any alloy combination he wishes. Half a dozen different combinations are in use, as Gregg and Daniloff [1] show, each favored by a producer who has developed his technique to handle a particular analysis.

The high-yield steels are too new for all possible or practical low-cost analyses to have been thoroughly studied and evaluated, so there is still need to consider the unexplored possibilities. Since these are destined to be tonnage steels, there is every incentive to study all the possible alloying elements.

"Nuisance," or Alloy?

The average metallurgical text-book gives a list of alloying elements for steel and another list of "impurities," or "nuisance elements," such as oxygen, nitrogen, sulphur and phosphorus, which, the reader is told, should be kept to the absolute minimum. Yet today a regulated oxygen content, sufficient to combine with aluminum, titanium, etc., to produce oxide nuclei to serve in the control of grain size, is a most important factor in steel making; nitrogen gives us the nitrided steels; sulphur, as well as phosphorus, is added in free-cutting steels and phosphorus is also added to steel for sheets to be pack-rolled.

All these elements are acquiring a certain status as useful alloying elements, though none of them can be effectively used in very large percentages. However, one of these, phosphorus, is of sufficient importance to call for the commercial production of ferrophosphorus, which is available cheaply and in quantity. The question arises whether phosphorus may not be suitable for wider use as a true alloying element.

That it is a true strengthening element is recorded in all the text books, on the basis of the studies of Campbell,[2] Webster [3] and others, who showed that, in structural steel, 0.01 per cent P has approximately the same hardening and strengthening effect as 0.01 per cent C. Several of the text books (including some of the more recent ones [4,5] but excluding that of Hoyt,[6] who in 1921 clearly appraised the situation) repeat a statement made by Howe [7] in 1891 on the basis of tests on commercial steels, to the effect that the strengthening effect holds only to 0.12 per cent P and that, above that amount, its entrance causes the tensile strength to drop, and brittleness ("cold-shortness") to appear, hence the upper limit for phosphorus in steel is set at 0.10 per cent.

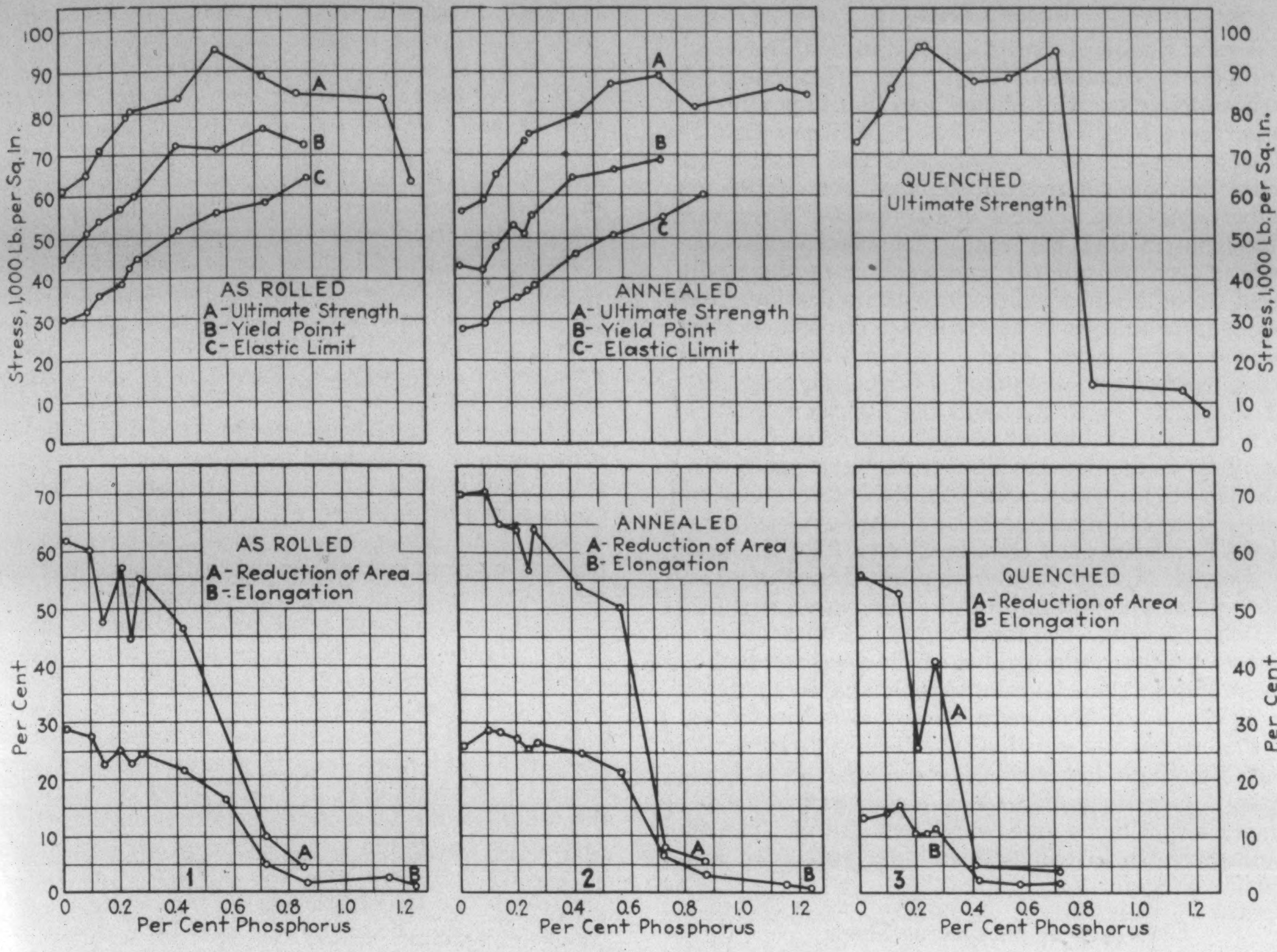
Both statements are based on the fallacious judging of the whole from a part, and concluding that, because phosphorus is harmful in steels already made quite hard by carbon, it should be equally harmful in low-carbon steels. Nearly every alloying element has suffered from the tendency of its proponents to keep the carbon up when the alloy was introduced. The utilization of medium manganese steels was considerably delayed while the necessity for holding the carbon down was being realized. In forging steels, spring steels and the like, increase in phosphorus above the usual figure might be unwarranted, but there is good evidence that, in very low-carbon steels, the phosphorus content may rise above the usual figure without detriment, and often with benefit.

Early Knowledge and Use of Phosphorus

The early steel-makers knew this. John Fritz [8] knew it in 1874, and R. W. Hunt [9] in 1885 mentioned a steel of 0.08 per cent C, 0.01 per cent Si, 0.48 per cent Mn, 0.09 per cent S and 0.50 per cent P that gave 80,000 lb. per sq. in. tensile, 59,000 lb. per sq. in. yield, 23 per cent elongation and 36 per cent reduction of area. This steel meets the static strength requirements for modern "high yield" steels.

Such steels were in commercial use in those days. At a meeting of the American Institute of Mining Engineers Hunt exhibited a shovel made of a similar steel with 0.11 per cent C, 0.35 per cent P that formed perfectly in being turned over to form the socket for the handle and made a high grade shovel. In discussion Ward [9a] quotes a remark by Hackney [9b] in 1874 or 1875 that high phosphorus could be used "if the carbon and probably also the silicon were kept low enough."

Raymond [10] in 1874 commented on the finding by



Figs. 1, 2 and 3. Tensile Properties of As-Rolled, Annealed and Quenched (Untempered) Phosphorus Steels of around 0.15% C, as determined by d'Amico.[13]

the Terrenoir works in France that a 0.15 per cent C, 0.35 per cent P steel was a good one, to the effect that this was common knowledge in the United States and cites letters of J. B. Britton written in 1870 and 1871 that it was known "long ago" and asserted by Karsten that 0.50 per cent P could be used in bar iron before cold-shortness ensued, but that Karsten neglected to consider how much carbon could be present. Britton himself stated that 0.06 per cent C with 0.30 per cent P and 0.20 per cent C with 0.08 per cent P were admissible.

Phosphorus in Wrought Iron

Phosphorus has never been frowned upon in wrought iron, which is always of very low-carbon content. Rawdon and Epstein [11] found that strength and other advantages increased as phosphorus rose to 0.20 per cent and only at still higher percentages was shock resistance affected. In 1934 the Committee on Quality Standards for Wrought Iron of the American Society for Testing Materials [12] stated that excellent wrought iron could vary in phosphorus from 0.10 per cent or less to 0.25 per cent or more.

It is generally conceded that while the higher ranges may drop a little in impact resistance, strength, weldability and machinability are improved so that phosphorus is an accepted alloying element in wrought iron.

Steels Tested by d'Amico

A very extensive study of phosphorus in low-carbon steel was made by d'Amico [13] and reported in 1912. His steels were made from commercial low-carbon steel by adding ferrophosphorus in the ladle. He covered the range from 0.012 per cent to 1.24 per cent P, using steel of 0.11 to 0.15 per cent C, 0.40 to 0.60 per cent Mn, 0.17 to 0.25 per cent Si and 0.05 to 0.08 per cent S.

Ingots of 220 lb. were cast and rolled to 1⅜-in. rounds. Among his results were the following:

Carbon, per cent	Phos., per cent	Tensile, lb. per sq. in.	Yield, lb. per sq. in.	Elastic Limit	Elong., per cent	R. A., per cent	Specific Impact Resistance Charpy, kmg. per sq. cm.*	Brinell
		As rolled						
0.12	0.012	60,500	45,000	30,000	28	61½	32½	132
0.14	0.245	78,000	57,500	42,500	22	43½	11	170
		Annealed 900 deg. C.—furnace cooled						
0.12	0.012	55,000	42,000	27,500	26½	70	35	119
0.14	0.245	71,500	50,500	39,000	25	55½	17	156
		Quenched 900 deg. C.—water—not tempered						
0.12	0.012	71,500	55,500	.....	12½	55½	30½	185
0.14	0.245	95,500	.....	.....	10	36	17½	225

* Specimen 25 x 25 mm., notch 12.5 mm. deep, radius of notch 1 mm.

Here again we have a high yield point steel that would meet modern tensile specifications. The tensile and impact curves obtained by d'Amico are shown in Figs. 1 to 4. Beyond 0.25 per cent P, with the carbon content at around 0.14 per cent, impact resistance fell rapidly, though static ductility held up rather well, save in the quenched and untempered condition, at 0.50 per cent P. The tensile curves show decisively that strength does not fall off when 0.12 per cent P is exceeded.

Unger's Tests

The next major investigation dealing with mechanical properties was that of Unger[14] in 1918. He made a very complete study of phosphorus in 0.12 per cent C, 0.36 per cent Mn, 0.036 per cent S, 0.02 per cent Si, 0.01 per cent Cu steels, both acid and basic open-hearth, with phosphorus in steps of about 0.02 per cent, between 0.032 per cent in acid and 0.008 per cent in basic, up to 0.11 per cent. The phosphorus was added, as ferrophosphorus, and was not residual. Increased strength and yield point, with no definite effect on elongation and only minor effect on reduction of area, was noted either in the as-rolled condition, or water quenched and tempered. Charpy impact tests ran from 32 to 49 ft. lb., with the highest impact, in each series, at the highest phosphorus content.

Many types of "workability" tests were made, longitudinal and transverse bending, drift test, shear on riveted joints, cold bend and flattening tests on rivets, bend tests and Ericksen tests on sheet. The Ericksen tests showed slightly smaller depth of cup as phosphorus increased, normal for the increased strength. Sheet was stamped into lamp cups, hub cups, drawn into steel barrels, running board shields, automobile cowls, radiator casings, corner panels and cream separator bowls. No difference at all was noted in workability that would not equally have been noted had the increased strength and hardness come from an increase in carbon. Groesbeck [15] made a metallographic study of Unger's specimens and found that the phosphorus had non-uniform distribution and the grain size was somewhat irregular.

Endurance of Phosphorus Steels

Campbell [2] had condemned phosphorus in steel for use under repeated stress or, as he termed it, "incessant tremor." Stead [16] had shown that, at a given stress, rotating beam results were higher with higher phosphorus, but it was not till 1925 that real endurance tests were made. Stead and Unger had reported Arnold repeated bending or similar tests at high stresses, and Higgins [17] later made the so-called "vibratory" test on wrought iron high in phosphorus, but stress-cycle curves to show the endurance limit had not been determined. Such curves were given by McIntosh and Cockrell [18] who used four steels of 0.09 to 0.11 per cent C, 0.50 per cent Mn, 0.035 to 0.052 per cent S with phosphorus ranging from 0.012 to 0.085 per cent.

The endurance limit rose with the phosphorus, and the endurance ratios were from 49 to 55 per cent. The highest and lowest phosphorus steels were also given an endurance test using notched bars, the higher phosphorus steel gave a higher notched endurance limit than the lower one. The steels were found to be normal on the McQuaid-Ehn test. The phosphorus, save in the steel of lowest phosphorus content, was added, not residual. McIntosh and Cockrell comment on the possibility that residual and added phosphorus may not act exactly the same. A similar distinction has been drawn in the plans of the Joint Committee on Investigation of the Effect of Phosphorus and Sulphur in Steel,[19] whose program includes the study of both added and residual phosphorus. Only the added phosphorus part of the program has been carried out.

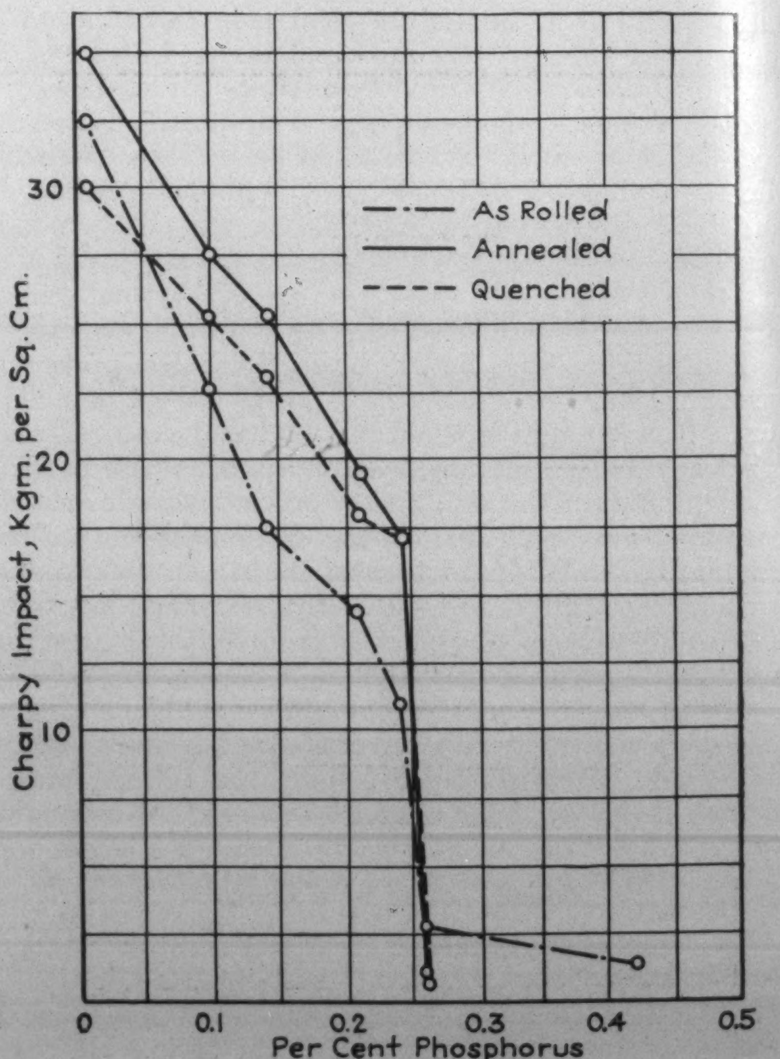
The Joint Committee's Work on Phosphorus

Since commercial welded steel pipe is rephosphorized with ferrophosphorus for better weldability, the phosphorus contents studied, aside from the steel lowest in that element (0.007 per cent), were obtained in that manner, the content being raised to 0.05, 0.06 and 0.08 per cent, in basic open-hearth steels of 0.10 to 0.12 per cent C, 0.48 per cent Mn, 0.01 to 0.03 per cent Si, and 0.03 per cent S, with residual nickel from nil to 0.026 per cent, copper, 0.02 to 0.08 per cent, and chromium, 0.005 to 0.014 per cent. The steels were given mold additions of ferrosilicon and aluminum. Longitudinal and transverse tensile, shear, cold bend, Charpy impact and Charpy tension impact tests made at the United States Naval Engineering Experiment Station were reported by Rawdon on specimens as rolled, annealed at 1725 deg. F (940 deg. C.) and furnace cooled, and water quenched from the same temperature.

The tensile and shear specimens showed the usual increase in strength with increased phosphorus. The static ductility was scarcely affected and the bend test, on as-rolled or annealed materials, was good, without regard to the phosphorus, though the effect of phosphorus in causing small cracks in the bend test specimens was evident in the quenched samples.

The Charpy impact results showed a peculiar variation. Three of the heats, including the lowest and highest phosphorus heats, showed about the same results, regardless of phosphorus. One heat, that with 0.06 per cent P and otherwise differing chemically from the other heats only in that the residual copper was 0.08 per cent, gave a lower impact resistance than the others in the as-received condition on longitudinal specimens, but in the annealed or quenched conditions its impact resistance was the highest of the lot. In the search for an expanation of this anomaly, it was found that this heat showed structural abnormality, doubtless connected with the manner of deoxidation. It had a coarser structure in the as-rolled condition. This factor far overbalanced any regular trend due to

Fig. 4. Specific Impact Resistance (Charpy) of d'Amico's Phosphorus Steels. For static properties see Figs. 1-3.



phosphorus content. The results indicate that brittleness in steels of such carbon and phosphorus contents may be due to factors entirely aside from the phosphorus factor.

Phosphorus Compared With Carbon

In a talk before the Penn State Chapter of the American Society for Metals in the fall of 1934, and again in the Robert Henry Thurston Lecture[20] before the American Society of Mechanical Engineers, Dr. John Johnston made the suggestion that, instead of classing phosphorus as a nuisance "element" and taking it down to low limits in steel-making at the expense of a severely oxidizing treatment, whose effects it may be hard to repair in deoxidation, phosphorus may well be considered as an alloying element similar to carbon, but some 3½ times as potent.

Effect Upon Corrosion Resistance

One of the first hints that phosphorus may have a beneficial effect upon corrosion resistance, in conjunction with other suitable alloying elements, was given by Storey,[21] who pointed out in 1921 that even on the small amount of data then available from the A. S. T. M. atmospheric exposure tests of copper-bearing steel, it was evident that the higher phosphorus copper steels were the most corrosion resistant, and predicted that as the tests progressed this fact would become more clear and a beneficial effect of phosphorus would be established.

In 1929 Kendall and Taylerson[22] published a statistical study of the A. S. T. M. tests which thoroughly bore out Storey's predictions. The steels ranged from about 0.02 to about 0.12 per cent C. In 22 gage sheets, exposed at Pittsburgh, the life of the non-copper (nil to 0.03 per cent Cu) specimens was from 500 to 700 days, irrespective of phosphorus content, but with those of 0.15 to 0.40 per cent Cu, the life increased from 1500 days at 0.01 to 0.03 per cent P to over 2500 days with 0.10 per cent P. In the non-copper steels exposed at Pittsburgh, no effect of phosphorus could be shown but at Fort Sheridan (rural atmosphere) the life rose from about 1500 days at 0.05 to 0.07 per cent P to 3500 days at 0.13 per cent P. (The copper-bearing steels lasted so long at Fort Sheridan that the exposure tests were terminated before any effect of phosphorus became evident.)

Diegel[23] made up 0.13 to 0.18 per cent C steels with from about 0.01 to 1.08 per cent P and found that the steels with higher phosphorus lost slightly less weight in 12 months' submersion in sea-water than did the one with only 0.01 per cent P. One of his steels with 0.23 per cent P had 89,000 lb. per sq. in tensile strength, 16 per cent elongation, while one with 0.45 per cent P had the same strength and 5 per cent elongation, while those with 0.85 and 1.08 per cent P were very brittle.

The slope of the curve for life at Pittsburgh vs. phosphorus content is even steeper than that vs. copper content. Kendall & Taylerson concluded that phosphorus combined with copper has very beneficial effects as to atmospheric corrosion. In total immersion tests there was no perceptible effect of any change in composition of the steel studied.

In the recently introduced commercial steel "Cor-Ten," described by Schramm, Taylerson and Striebing,[24] phosphorus is used as an alloying element along with copper, chromium and silicon. The composition is 0.10 per cent C, 0.10 to 0.30 per cent Mn, 0.10 to 0.20 per cent P, 0.05 per cent S max., 0.50 to 1.00 per cent Si, 0.30 to 0.50 per cent Cu, and 0.50 to 1.50 per cent Cr. The minimum tensile properties are 50,000 to 60,000 lb. yield strength, and 65,000 to 75,000 lb. per sq. in. tensile strength, with 27 to 22 per cent elongation, and the atmospheric corrosion resistance is stated to be 4 to 6 times that of plain carbon steel, and twice that of ordinary copper bearing steel. This composition, with broader limits, is given by Strauss[25] in a recent patent, who suggests the use of steels of:

	Per Cent		Per Cent
C	0.01 to 0.60	Mn	0.02 to 0.50
Cr	0.30 to 2.00	P	0.07 to 0.75
Cu	0.15 to 3.00	S	under 0.10
Si	0.25 to 3.00		

Speller[26] and Whetzel[27] also emphasize the resistance to atmospheric corrosion of the Cr-Cu-Si-P steel. In the normalized condition the Izod impact value for Cor-Ten is given as 60 ft.lb., certainly not a brittle steel, even though the phosphorus may rise to 0.20 per cent, and it is further stated that at —30 deg. F. the Izod is at least twice that for ordinary low-carbon open-hearth steel. Other alloy combinations outside the Cor-Ten range can be chosen that will also avoid impact brittleness. The workability and weldability are rated as satisfactory, and the steel is not air-hardening.

(To be concluded)

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Properties of Wrought Aluminum Alloys at Elevated Temperatures

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THIS IS THE SECOND of a series of papers from the Research Laboratories of the Aluminum Co. of America reporting the effects of prolonged heating at different temperatures upon the tensile properties of aluminum and aluminum alloys at both normal and elevated temperatures. The former paper[1] included commercially pure aluminum (2S) and two of its alloys (3S and 4S). These materials are not amenable to heat treatment and were tested in the annealed and cold-worked conditions.

It was found that, when these materials in the cold-worked condition were heated at temperatures of 212 and 300 deg. F. for prolonged periods of time and then tested at the heating temperature, there was a marked tendency for their tensile strength and yield strength to increase as a result of relief of internal strain and the materials were not materially softened by prolonged exposure to these temperatures. It was also found that the materials with the greatest amount of cold work became more completely annealed at lower temperatures than those with intermediate amounts of cold work.

The present paper deals with a wide range of aluminum alloys susceptible to improvement by heat treatment. It is obvious, therefore, that these tests differ from those of the former investigation in that they involve removal of the effects of heat treatment instead of cold work.

The Materials Tested

The materials tested were secured in the form of ¾-in. diameter rolled rods and ¾-in. thick forged slabs. Their chemical compositions are shown in Table 1. The final letter of the alloy designation indicates the temper of the material. According to this nomenclature "O" is the annealed or dead-soft condition, "W" is quenched from a solution heat treatment and "T" means that the alloy has been quenched from a solution heat treatment and then aged—either spontaneously at room temperature or artificially at some temperature in the region of 340 deg. F. 14S, 18S, Y-alloy and 32S are primarily forging alloys.

Table I—Nominal Chemical Composition of Materials*

Material	Silicon, per cent	Copper, per cent	Manganese, per cent	Magnesium, per cent	Nickel, per cent	Chromium, per cent
14S-O	0.80	4.40	0.75	0.35	...	...
14S-T	0.80	4.40	0.75	0.35	...	...
17S-T	...	4.00	0.50	0.50	...	...
18S-O	...	4.00	...	0.50	2.00	...
18S-W	...	4.00	...	0.50	2.00	...
Y-alloy	...	4.00	...	1.50	2.00	...
24S-T	...	4.20	0.50	1.50	...	...
32S-T	12.50	0.80	...	1.15	0.80	...
51S-W	1.00	...	...	0.60	...	...
51S-T	1.00	...	...	0.60	...	...
A51S-T	1.00	...	...	0.60	...	0.25
53S-O	0.70	...	...	1.25	...	0.25
53S-T	0.70	...	...	1.25	...	0.25

* The compositions and/or heat treatments of many of these alloys are patented.

Method of Test

The method of test employed is essentially as follows: A number of standard ½-in. diameter tensile specimens of one material are placed in a furnace

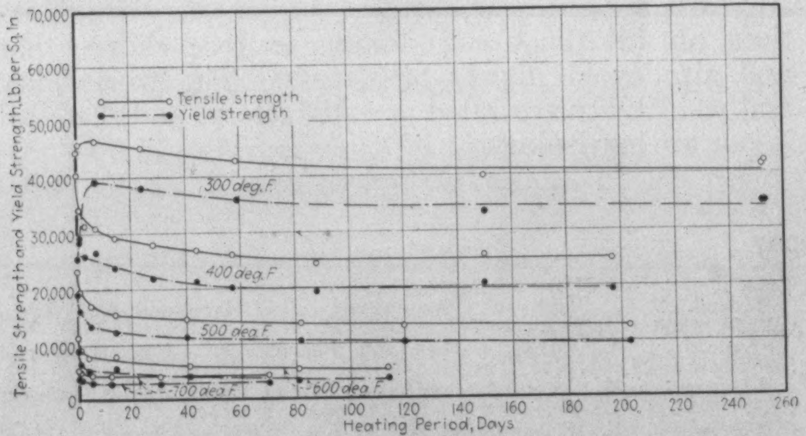

Fig. 1.—Tensile Strength and Yield Strength of Aluminum Alloy Rod at Different Temperatures.

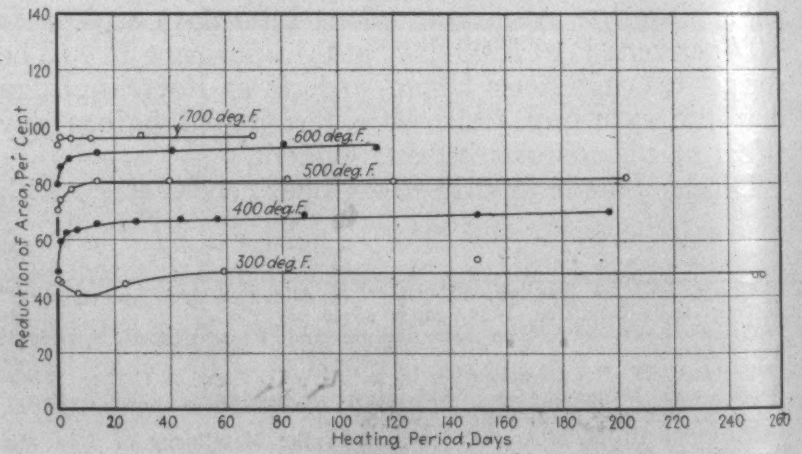

Fig. 3.—Reduction of Area of Aluminum Alloy at Elevated Temperatures.

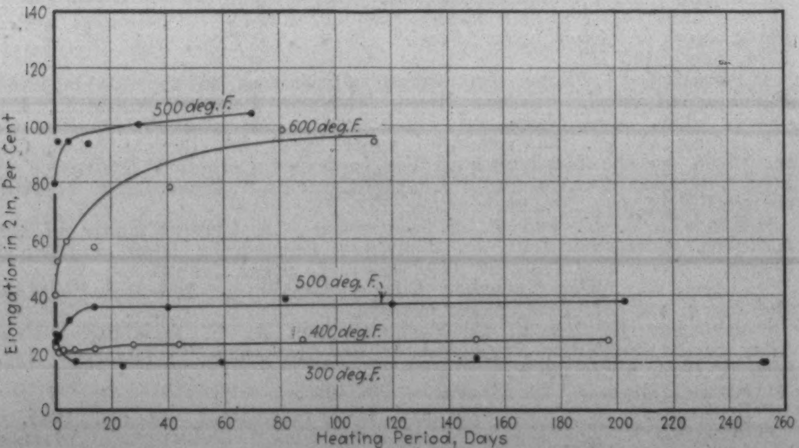

Fig. 2.—Elongation of Aluminum Alloy at Elevated Temperatures.

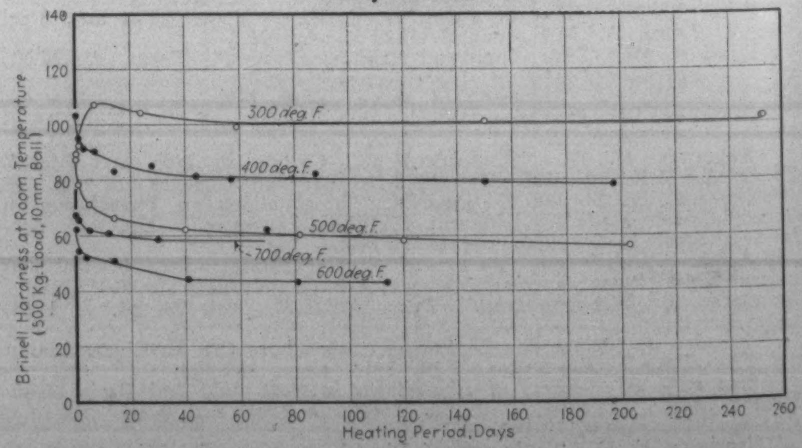

Fig. 4.—Brinell Hardness vs. Heating Period—Aluminum Alloy

operating at a constant temperature. A specimen is then removed from this furnace after a definite interval of time, quickly transferred to the furnace in which it is to be tested and, after temperature conditions have again reached equilibrium, the specimen is pulled. Tests are made at intervals in this manner until the material is completely stable and shows no further change of strength with increased exposure to temperature. These tests are made at 300, 400, 500, 600 and 700 deg. F.

In addition to the tests described above, hardness tests were made at room temperature on all the specimens broken at elevated temperatures and tensile tests were made at room temperature on the specimens that had been completely stabilized at the various elevated temperatures.

Discussion of Results

Table II is a summary of the tensile properties obtained at elevated temperatures after prolonged heating at the testing temperature while Table III is a summary of the tensile property and hardness values at room temperature obtained after corresponding heating periods. The values listed in Tables II and III have been selected from mechanical property-heating period curves of the type shown in Figs. 1, 2, 3 and 4 for duralumin (17S-T).

The shape of the mechanical property-heating period curves is, in general, the same for all the heat-treated wrought aluminum alloys. When the alloys are heated at a constant elevated temperature and then tested at the heating temperature, there is a marked tendency for their tensile strength and yield strength to decrease and for their elongation and reduction of area to increase. The plot of these tensile properties for each temperature against time is a curve which apparently approaches a horizontal asymptote, the inflection of the curve being downward for tensile strength and yield strength and upward for elongation and reduction of area.

Exceptions to this behavior are noted in the case of alloys that have been heat treated but are susceptible to further improvement in strength by means of artificial aging. In such instances, at temperatures in the region of 200 to 300 deg. F. the trends of the mechanical property-heating period curves are as described only after the tensile strength and yield strength have reached maximum and elongation and reduction of area minimum values. Obviously, these irregularities are more noticeable in the case of alloys given only a solution heat treatment.

Tensile strength, yield strength, elongation and reduction of area for each alloy, at room temperature after prolonged heating and at elevated temperatures after prolonged heating, have been plotted against heating temperature in Figs. 5 to 17. These curves show the tensile property values at temperatures up to 700 deg. F. after the material has been completely stabilized at the testing temperature and the corresponding room temperature values. These curves do not show the change in property values produced by long-time heating (as do Figs. 1 to 4), but by comparing the room-temperature curve with the elevated-temperature curve it is possible to note the actual change in any of the tensile properties caused by exposure to any of the elevated temperatures after prolonged heating at that temperature.

For example, as shown by Fig. 7, the tensile strength of 17S-T at 300 deg. F., after prolonged heating at

Table II.—Tensile Properties of Wrought Aluminum Alloys at Elevated Temperatures After Prolonged Heating At Testing Temperature

Material	Property	Temperature, deg. Fahr.					
		75	300	400	500	600	700
14S-O	Tensile strength, lb. per sq. in.	27,620	17,300	9,000	6,600	4,700	4,100
	Yield strength (Set = 0.2%), lb. per sq. in.	11,050	9,400	5,800	4,700	3,400	2,900
	Elong. in 2 in., per cent	24	42	61	59	63	71
	Red. of area, per cent	48	66	81	85	87	88
14S-T	Tensile strength, lb. per sq. in.	67,400	46,800	17,000	10,000	6,200	4,500
	Yield strength (Set = 0.2%), lb. per sq. in.	57,000	39,200	12,400	7,600	5,000	3,400
	Elong. in 2 in., per cent	16	18	36	50	68	73
	Red. of area, per cent	31	51	85	93	97	98
17S-T	Tensile strength, lb. per sq. in.	58,965	40,200	25,000	12,750	5,400	4,250
	Yield strength (Set = 0.2%), lb. per sq. in.	36,000	33,500	20,000	9,700	3,500	3,000
	Elong. in 2 in., per cent	24	17	25	38	100	104
	Red. of area, per cent	40	48	69	81	94	96
18S-O	Tensile strength, lb. per sq. in.	24,600	19,500	10,000	7,000	4,300	3,250
	Yield strength (Set = 0.2%), lb. per sq. in.	10,200	11,500	5,800	4,100	2,400	1,900
	Elong. in 2 in., per cent	22	25	39	76	85	92
	Red. of area, per cent	33	37	55	72	77	83
18S-W	Tensile strength, lb. per sq. in.	24,600	19,500	10,100	7,000	4,300	3,250
	Yield strength (Set = 0.2%), lb. per sq. in.	30,800	32,000	15,500	.....	2,800	1,900
	Elong. in 2 in., per cent	21	17	30	.....	90	130
	Red. of area, per cent	31	30	50	.....	85	93
Y-alloy	Tensile strength, lb. per sq. in.	59,500	42,000	26,000	12,500	6,400	3,800
	Yield strength (Set = 0.2%), lb. per sq. in.	40,600	36,500	20,000	7,500	3,400	1,800
	Elong. in 2 in., per cent	15	10	14	28	60	119
	Red. of area, per cent	16	24	34	60	80	91
24S-T	Tensile strength, lb. per sq. in.	68,800	46,500	27,500	14,000	7,500	5,100
	Yield strength (Set = 0.2%), lb. per sq. in.	47,500	38,500	21,400	9,400	4,600	3,400
	Elong. in 2 in., per cent	17	18	24	43	71	98
	Red. of area, per cent	35	48	63	86	94	96
32S-T	Tensile strength, lb. per sq. in.	52,800	36,800	15,500	9,000	5,500	3,400
	Yield strength (Set = 0.2%), lb. per sq. in.	44,500	32,500	11,000	6,200	3,400	1,800
	Elong. in 2 in., per cent	6	6	23	39	47	80
	Red. of area, per cent	10	15	42	54	66	82
51S-W	Tensile strength, lb. per sq. in.	35,865	27,700	13,200	5,200	3,250	2,100
	Yield strength (Set = 0.2%), lb. per sq. in.	17,250	23,250	10,100	3,500	2,100	1,300
	Elong. in 2 in., per cent	32	16	32	78	88	114
	Red. of area, per cent	56	42	76	93	97	99
51S-T	Tensile strength, lb. per sq. in.	45,520	28,000	14,100	5,250	3,100	2,100
	Yield strength (Set = 0.2%), lb. per sq. in.	35,625	24,250	11,000	3,500	2,000	1,400
	Elong. in 2 in., per cent	16	19	31	65	91	117
	Red. of area, per cent	28	47	73	92	98	99
A51S-T	Tensile strength, lb. per sq. in.	47,000	19,200	7,300	5,700	4,200	3,300
	Yield strength (Set = 0.2%), lb. per sq. in.	40,700	15,500	5,500	4,600	3,500	2,850
	Elong. in 2 in., per cent	19	28	57	58	58	63
	Red. of area, per cent	47	66	91	93	93	94
53S-O	Tensile strength, lb. per sq. in.	14,870	10,300	7,700	5,300	3,600	2,600
	Yield strength (Set = 0.2%), lb. per sq. in.	5,650	5,000	4,500	2,550	2,300	1,800
	Elong. in 2 in., per cent	39	47	53	66	79	98
	Red. of area, per cent	68	73	80	86	90	91
53S-T	Tensile strength, lb. per sq. in.	36,100	24,300	13,100	5,700	3,700	2,700
	Yield strength (Set = 0.2%), lb. per sq. in.	27,400	21,000	9,800	3,400	2,500	1,950
	Elong. in 2 in., per cent	24	20	35	78	79	88
	Red. of area, per cent	54	62	73	89	92	93

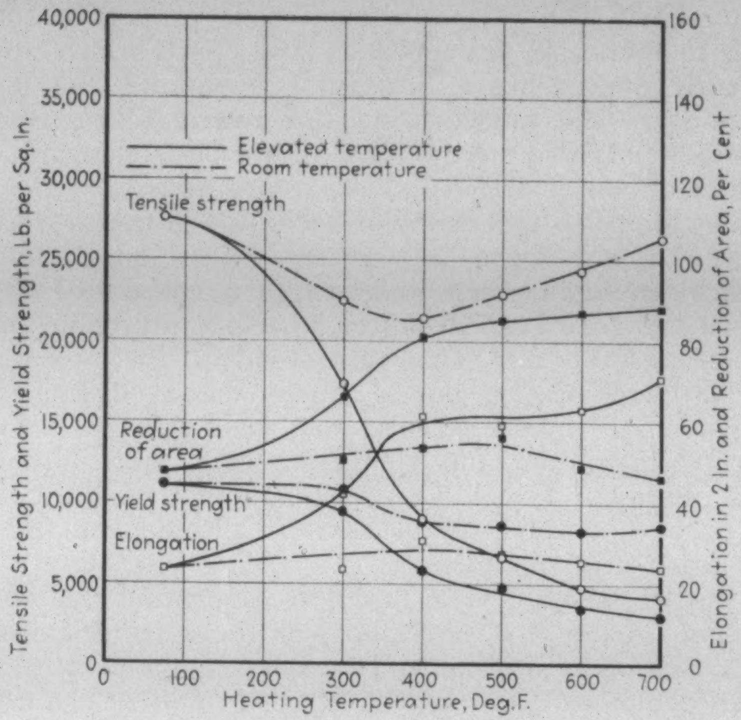

Fig. 5.—Tensile Strength, Yield Strength, Elongation and Reduction of Area of Aluminum Alloy Rod at Room and Elevated Temperatures.

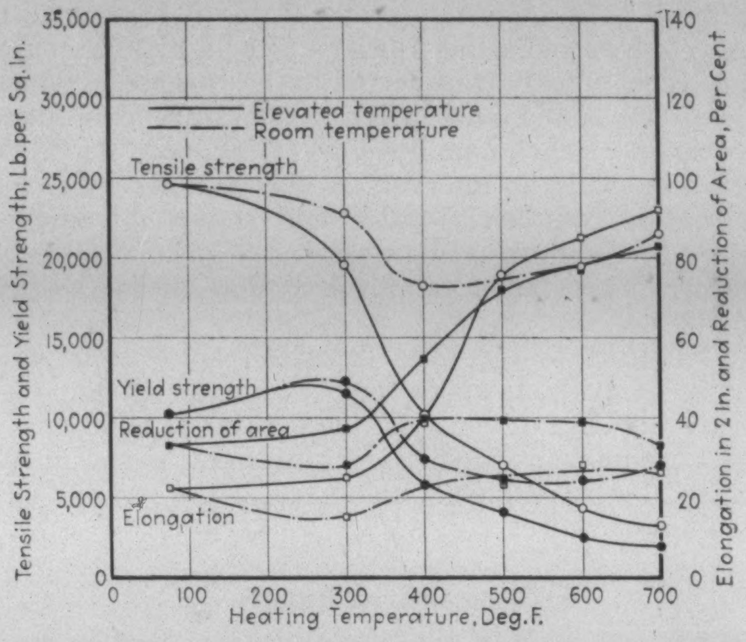

Fig. 8.—Tensile Strength, Yield Strength, Elongation and Reduction of Area of Aluminum Alloy Rod at Room and Elevated Temperatures.

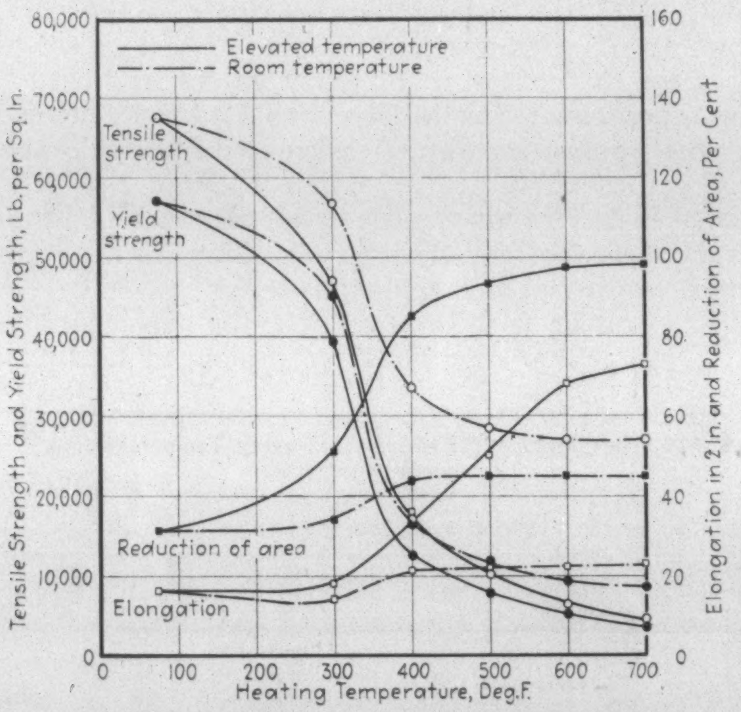

Fig. 6.—Tensile Strength, Yield Strength, Elongation and Reduction of Area of Aluminum Alloy Forged Slab at Room and Elevated Temperatures.

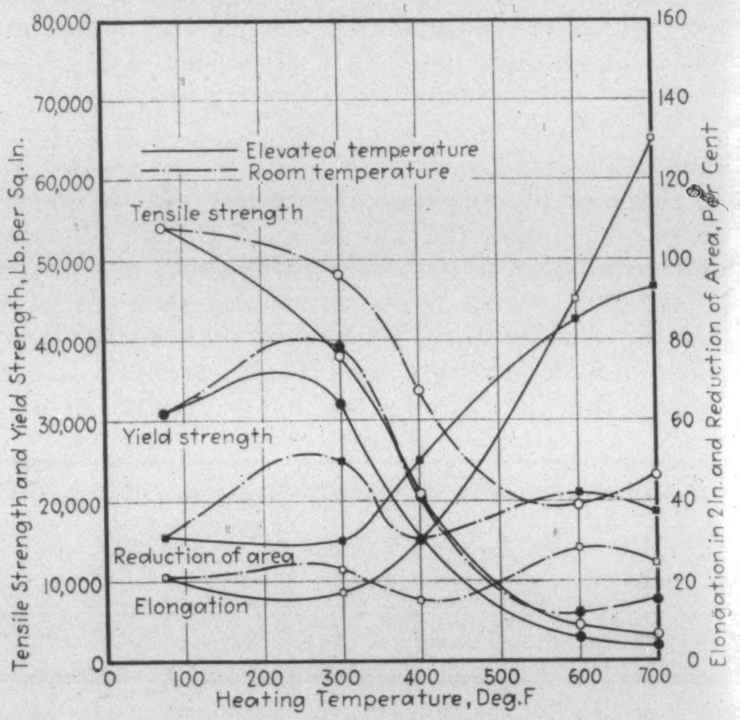

Fig. 9.—Tensile Strength, Yield Strength, Elongation and Reduction of Area of Aluminum Alloy Rod at Room and Elevated Temperatures.

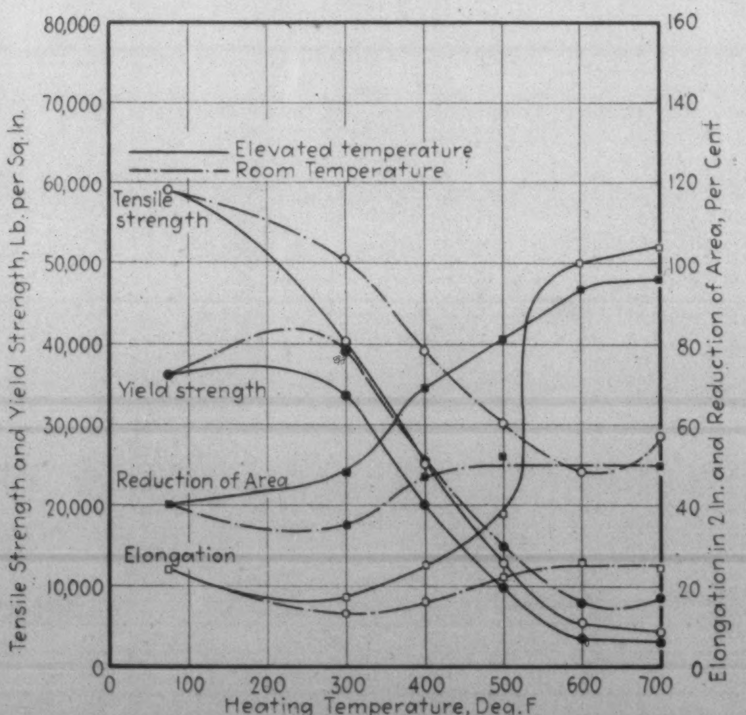

Fig. 7.—Tensile Strength, Yield Strength, Elongation and Reduction of Area of Aluminum Alloy Rod at Room and Elevated Temperatures.

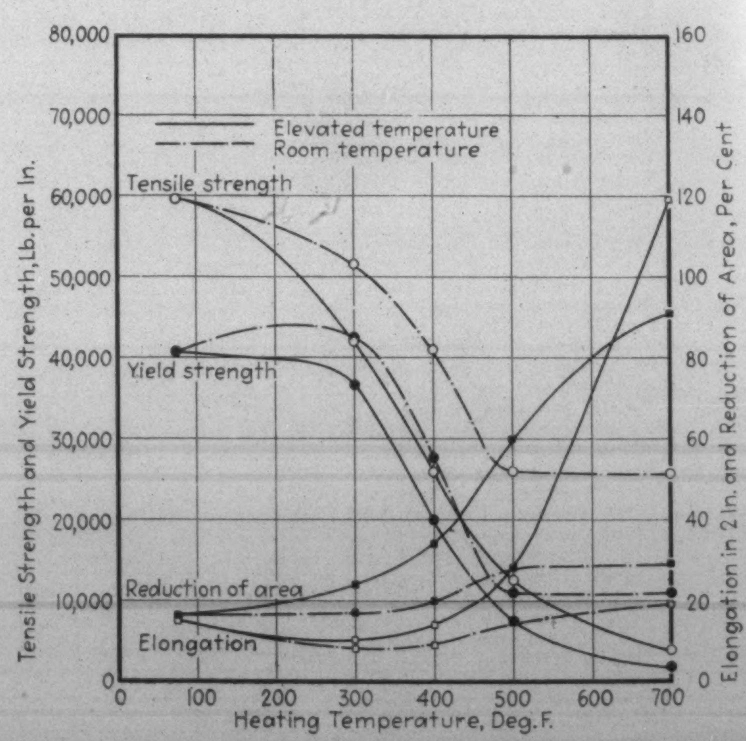

Fig. 10.—Tensile Strength, Yield Strength, Elongation and Reduction of Area of Aluminum Alloy Forged Slab at Room and Elevated Temperatures.

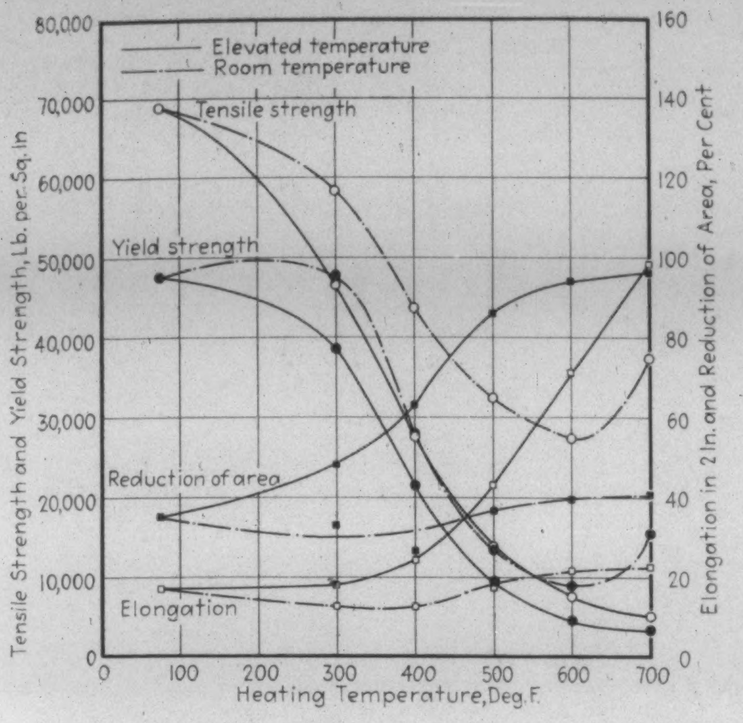

Fig. 11.—Tensile Strength, Yield Strength, Elongation and Reduction of Area of Aluminum Alloy Rod at Room and Elevated Temperatures.

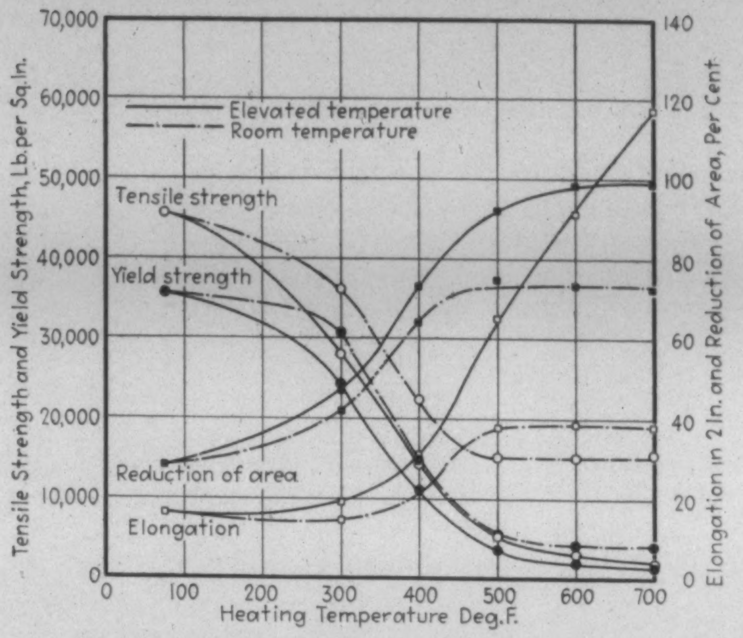

Fig. 14.—Tensile Strength, Yield Strength, Elongation and Reduction of Area of Aluminum Alloy Rod at Room and Elevated Temperatures.

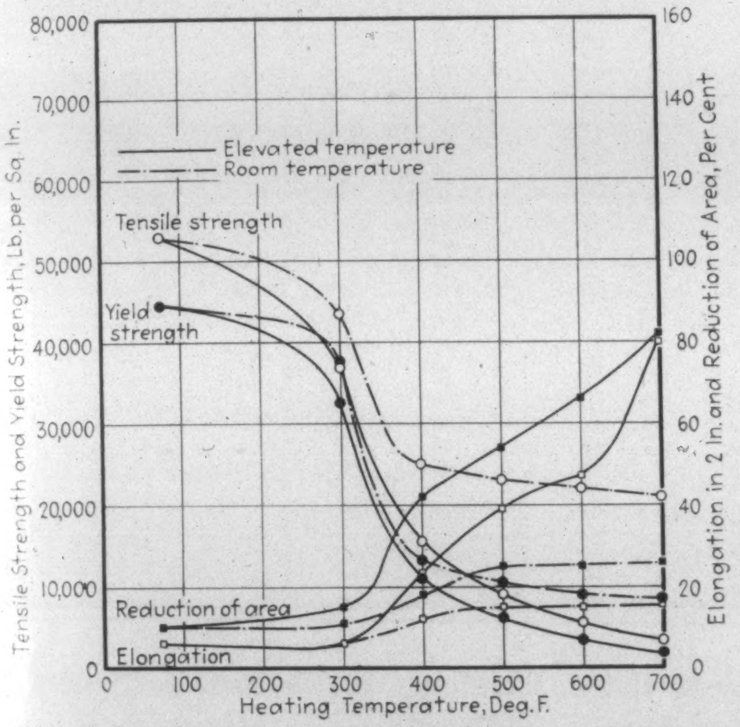

Fig. 12.—Tensile Strength, Yield Strength, Elongation and Reduction of Area of Aluminum Alloy Forged Slab at Room and Elevated Temperatures.

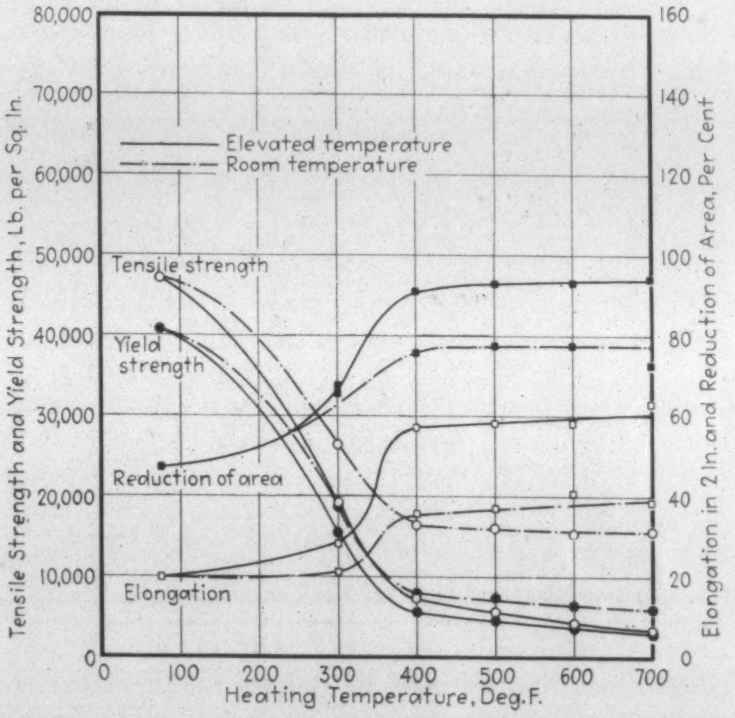

Fig. 15.—Tensile Strength, Yield Strength, Elongation and Reduction of Area of Aluminum Alloy Rod at Room and Elevated Temperatures.

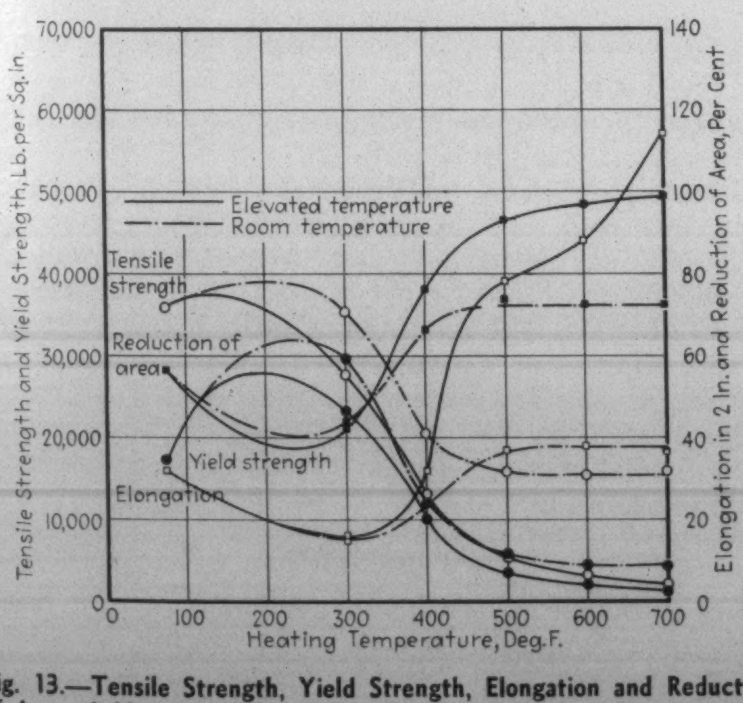

Fig. 13.—Tensile Strength, Yield Strength, Elongation and Reduction of Area of Aluminum Alloy Rod at Room and Elevated Temperatures.

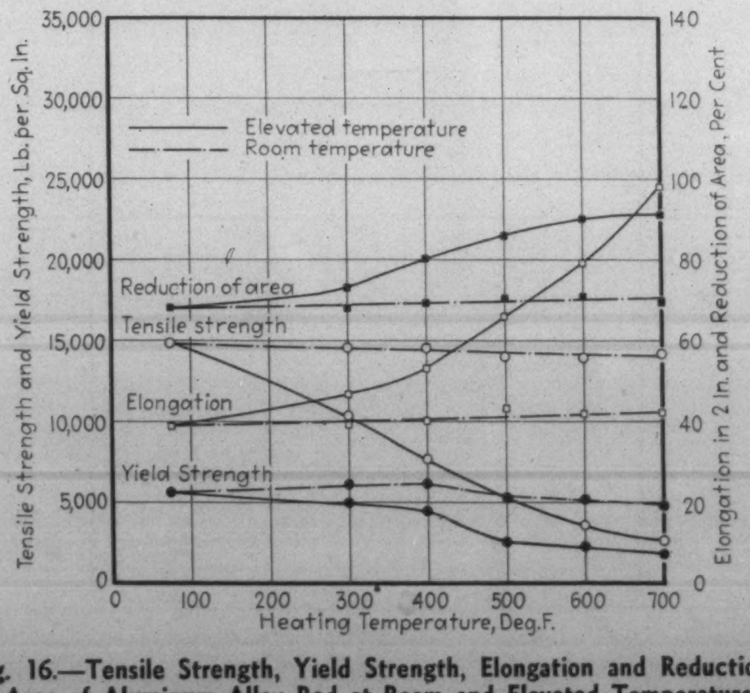

Fig. 16.—Tensile Strength, Yield Strength, Elongation and Reduction of Area of Aluminum Alloy Rod at Room and Elevated Temperatures.

Table III.—Tensile Properties and Hardness of Wrought Aluminum Alloys At Room Temperature After Prolonged Heating

Material	Property	Heating Temperature, deg. Fahr.					
		75	300	400	500	600	700
14S-O	Tensile strength, lb. per sq. in.	27,620	22,440	21,340	22,820	24,300	26,280
	Yield strength (Set = 0.2%), lb. per sq. in.	11,050	10,750	8,775	8,525	8,150	8,500
	Elong. in 2 in., per cent	24	24	31	28	26	24
	Red. of area, per cent	48	51	54	56	49	46
	Brinell hardness (500 kg. load, 10 mm. ball)	44	43	38	41	42	46
14S-T	Tensile strength, lb. per sq. in.	67,400	56,500	33,500	28,500	27,000	27,000
	Yield strength (Set = 0.2%), lb. per sq. in.	57,000	45,000	16,500	11,600	9,200	8,500
	Elong. in 2 in., per cent	16	14	21	22	22	23
	Red. of area, per cent	31	34	44	45	45	45
	Brinell hardness (500 kg. load, 10 mm. ball)	131	116	63	54	49	48
17S-T	Tensile strength, lb. per sq. in.	58,965	50,335	38,970	29,980	24,000	28,580
	Yield strength (Set = 0.2%), lb. per sq. in.	36,000	39,000	25,500	14,700	7,800	8,400
	Elong. in 2 in., per cent	24	13	16	22	26	25
	Red. of area, per cent	40	35	48	52	49	50
	Brinell hardness (500 kg. load, 10 mm. ball)	99	100	78	56	43	58
18S-O	Tensile strength, lb. per sq. in.	24,600	22,750	18,200	18,900	19,400	21,500
	Yield strength (Set = 0.2%), lb. per sq. in.	10,200	12,300	7,400	6,100	6,100	7,000
	Elong. in 2 in., per cent	22	15	23	24	28	26
	Red. of area, per cent	33	28	40	39	39	33
	Brinell hardness (500 kg. load, 10 mm. ball)	40	42	35	32	34	40
18S-W	Tensile strength, lb. per sq. in.	54,000	48,200	33,600	.....	19,400	23,100
	Yield strength (Set = 0.2%), lb. per sq. in.	30,800	39,100	20,500	.....	6,100	7,550
	Elong. in 2 in., per cent	21	23	15	.....	28	24
	Red. of area, per cent	31	50	31	.....	42	37
	Brinell hardness (500 kg. load, 10 mm. ball)	91	97	69	.....	36	42
Y-alloy	Tensile strength, lb. per sq. in.	59,500	51,500	41,000	26,000	.....	25,700
	Yield strength (Set = 0.2%), lb. per sq. in.	40,600	42,500	27,700	11,000	.....	11,000
	Elong. in 2 in., per cent	15	8	9	14	.....	19
	Red. of area, per cent	16	17	20	28	.....	29
	Brinell hardness (500 kg. load, 10 mm. ball)	118	105	80	50	.....	63
24S-T	Tensile strength, lb. per sq. in.	68,800	58,380	43,560	32,300	27,250	37,240
	Yield strength (Set = 0.2%), lb. per sq. in.	47,500	47,600	27,800	13,375	8,875	15,300
	Elong. in 2 in., per cent	17	13	13	18	22	23
	Red. of area, per cent	35	33	26	37	39	40
	Brinell hardness (500 kg. load, 10 mm. ball)	108	104	81	55	45	71
32S-T	Tensile strength, lb. per sq. in.	52,800	43,500	25,000	23,000	22,000	21,000
	Yield strength (Set = 0.2%), lb. per sq. in.	44,500	37,500	13,200	10,500	9,000	8,500
	Elong. in 2 in., per cent	6	6	12	15	15	16
	Red. of area, per cent	10	11	18	25	25	26
	Brinell hardness (500 kg. load, 10 mm. ball)	126	100	55	49	43	42
51S-W	Tensile strength, lb. per sq. in.	35,865	35,300	20,500	15,785	15,440	15,890
	Yield strength (Set = 0.2%), lb. per sq. in.	17,250	29,500	12,200	5,700	4,475	4,300
	Elong. in 2 in., per cent	32	15	24	37	38	37
	Red. of area, per cent	56	44	66	74	72	73
	Brinell hardness (500 kg. load, 10 mm. ball)	70	75	39	29	27	28
51S-T	Tensile strength, lb. per sq. in.	45,520	36,020	22,310	15,230	15,060	15,540
	Yield strength (Set = 0.2%), lb. per sq. in.	35,625	30,700	14,650	5,550	4,250	4,000
	Elong. in 2 in., per cent	16	15	22	38	39	38
	Red. of area, per cent	28	42	64	75	73	73
	Brinell hardness (500 kg. load, 10 mm. ball)	94	74	43	29	27	27
A51S-T	Tensile strength, lb. per sq. in.	47,000	26,390	16,410	15,980	15,280	15,590
	Yield strength (Set = 0.2%), lb. per sq. in.	40,700	18,800	7,800	7,300	6,375	5,950
	Elong. in 2 in., per cent	19	21	36	37	41	39
	Red. of area, per cent	47	68	76	77	78	73
	Brinell hardness (500 kg. load, 10 mm. ball)	99	55	31	32	30	30
53S-O	Tensile strength, lb. per sq. in.	14,870	14,570	14,540	14,010	13,910	14,210
	Yield strength (Set = 0.2%), lb. per sq. in.	5,650	6,125	6,200	5,300	5,200	4,800
	Elong. in 2 in., per cent	39	39	40	43	42	43
	Red. of area, per cent	68	68	69	70	71	70
	Brinell hardness (500 kg. load, 10 mm. ball)	27	28	28	28	27	27
53S-T	Tensile strength, lb. per sq. in.	36,100	31,840	21,850	16,150	15,030	14,850
	Yield strength (Set = 0.2%), lb. per sq. in.	27,400	26,900	12,700	5,050	4,900	4,850
	Elong. in 2 in., per cent	24	17	22	41	43	41
	Red. of area, per cent	54	56	64	67	70	71
	Brinell hardness (500 kg. load, 10 mm. ball)	74	66	42	30	29	28

300 deg. F., is about 40,000 lb. per sq. in. and its tensile strength at room temperature after the same heating period at 300 deg. F. is about 50,000 lb. per sq. in. It may be stated, therefore, that the tensile strength of 17S-T after prolonged heating at 300 deg. F. is about 10,000 lb. per sq. in. less at 300 deg. F. than at room temperature. These differences may also be noted by comparing the values listed in Tables II and III.

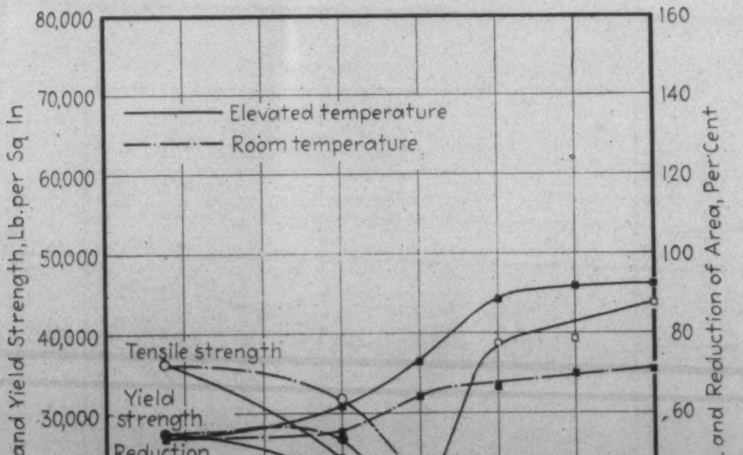

Fig. 17.—Tensile Strength, Yield Strength, Elongation and Reduction of Area of Aluminum Alloy Rod at Room and Elevated Temperatures.

The tendency of the prolonged heating is to change the room-temperature properties of the materials to properties representative of annealed materials. Under the conditions under which these tests are made, however, the minimum strength representative of fully annealed material is not always obtained. When the specimens are removed from the heating furnace, allowed to cool, and then are tested at room temperature, they may be partially heat treated as a result of air quenching. This is most noticeable in the case of 14S-O (Fig. 5). The room-temperature tensile strength of this alloy is at a minimum after being heated at 400 deg. F. and increases after being heated at higher temperatures. To fully soften most of the heat-treated aluminum alloys it is necessary to use a special annealing procedure.

Acknowledgment

The authors acknowledge the assistance of C. J. Renshaw in carrying out the tests and preparing the data.

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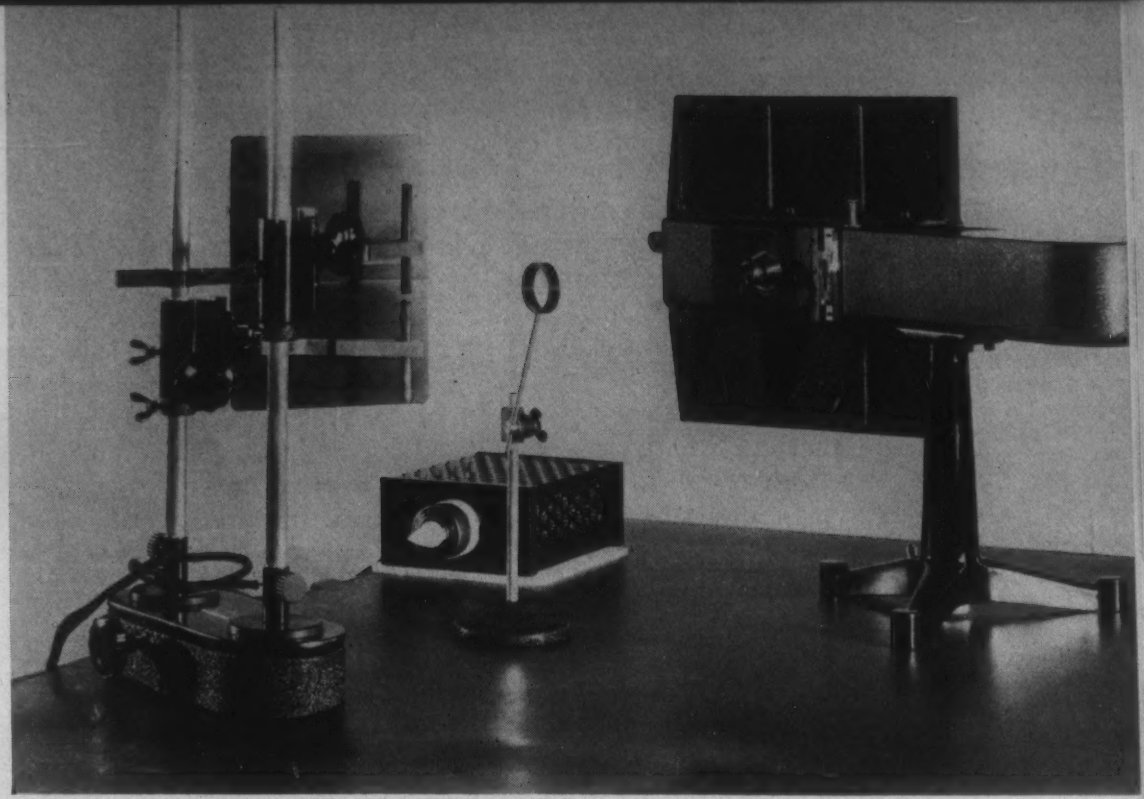
[1] "The Properties of Aluminum and Two of Its Alloys at Elevated Temperatures." *Metals and Alloys*, August, 1934.

Progress in Spectrographic Analysis—II

A Correlated Abstract



Small Littrow Spectrograph with Accessory Equipment. Arc and spark stand at left, condenser in center, and spectrograph at right. (Courtesy of Bausch & Lomb Optical Co.)

By THOMAS A. WRIGHT

Vice-President and Technical Director
Lucius Pitkin, Inc., New York

THIS is the second and concluding portion of the abstract by Mr. Wright. The other installment was published in the September issue.

Intensity Relationships

WOLFE[15] finds, in experimenting with the important factor of excitation conditions, that after a certain current through an arc is exceeded, additional arc current shows very little change in the relative intensities of a selected pair of spectral lines. Fig. 2, (curve 1 of the paper) for example, indicates that for a certain Ni-Cr alloy arc currents of 10 amp. or above would be satisfactory. The lines used in this case were chromium 4289.73 Å and nickel 4401.55 Å. If the spark source is used, it may be standardized by the method of Gerlach and Schweitzer.[40] For the determination of aluminum in nickel alloys 10 amperes was the minimum, with 15 amperes preferred in order to consume more sample and the aluminum line at 2660 Å was compared with that of nickel 2746 Å. For magnesium in zinc alloys, where ½-in. diameter electrodes were used, only 4 to 5 amp. with exposure for about 30 sec. was required. The magnesium line at 3832.17 Å. was compared with that of zinc at 3058.8 Å. For the range of 0.005 to 0.05 per cent Mg, the magnesium line at 2852.13 Å, as compared with that of zinc at 3035.8 Å, was preferred.

Because of change in contrast of the photographic plate with wave length the selected lines should be reasonably close together. Wolfe also brings out that accurate analyses can only be made with clear plates when densitometer measurements are employed and—that efforts to correct for background have not resulted in reliable corrections.

The determination of barium in nickel, while said to approximate the precision of chemical analysis, apparently has given trouble due to changes in line intensity the cause of which is not fully understood. Others too have noticed that some lines of an element may be very strongly affected by the presence of small amounts of other elements in the same alloy while other lines of the same element are not. Wolfe, however, confirms that at times the presence of certain elements in an alloy may affect the entire spectrum of the element being determined and suggests that this may be due to a change in the abundance of the element in the arc due to an increase in vapor pressure of the element added, especially for those easily placed in a vapor condition.

Changing relative line intensity may also be possible in those cases where close resonance exists between excited states of two elements. In mixtures it may be well to assume that such effects are occurring until proven otherwise. Most of those who have had any appreciable experience with any of the various methods, for this condition is common to all emission spectrography, will heartily agree that too little is known about this subject and that much work is desirable. The topic was the subject of considerable lobby discussion at the 1934 conference at M.I.T. Owens & Hess,[7] however, state they have found no such effect for manganese or silicon in magnesium. Twyman and Hitchen mention it.[14]

Owens and Hess, as also Wolfe, are obviously using the internal standard method of Gerlach and Schweitzer[40] as a base and coupled, as previously stated, with determinations of the relative intensity of the line-pair as obtained by means of a density-logarithm of intensity calibration pattern placed upon each plate and following along lines laid down by Hansen,[8-41] Von Hippel,[11] Read and Johnson,[9] Schachtschabel,[42] Duffendack, Wolfe, Smith and Thomson. [10, 15, 17, 31, 43] The latter group[15] state that a calibrated step diaphragm of either the Hansen type[8] or better one as devised by Thomson and Duffendack[10] may be employed.

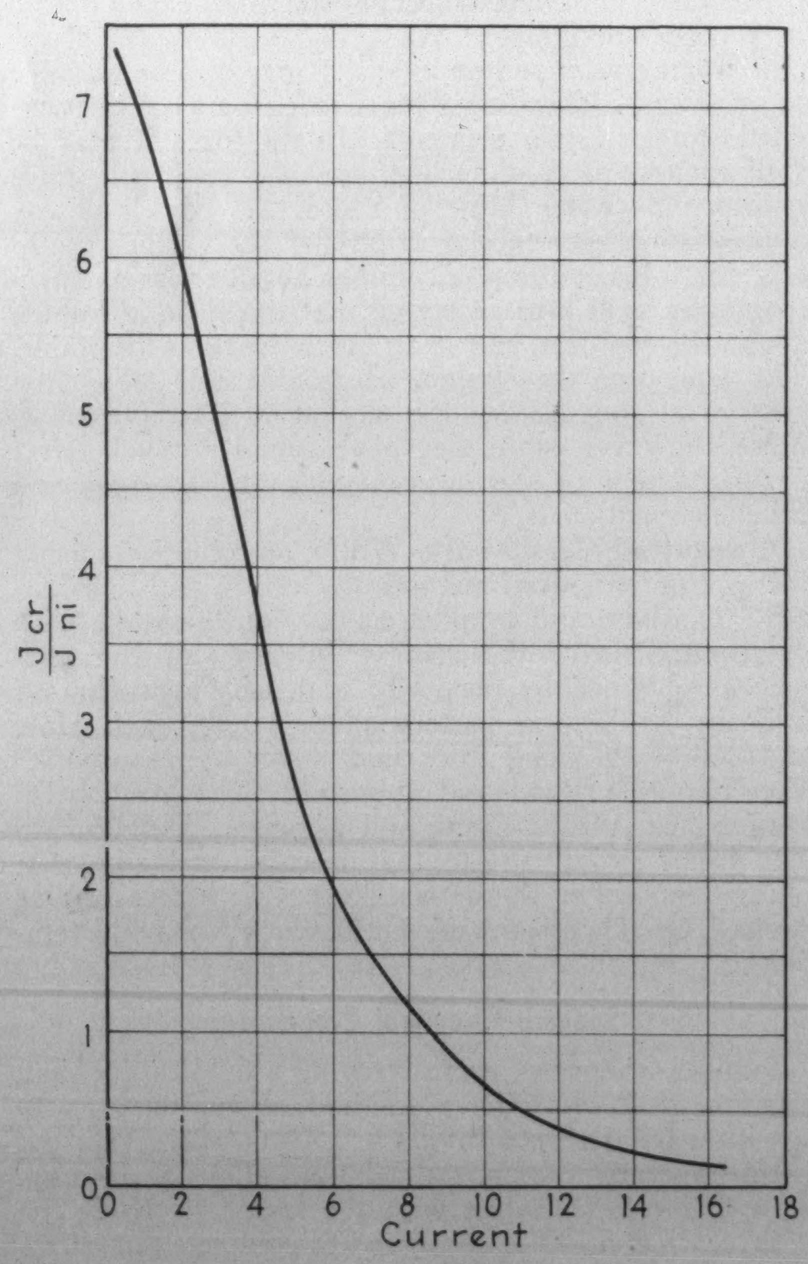
Spectro-Chemical Procedures

Stauss,[1] of course, was surveying a field rather than attempting to describe a method so no data as to specific excitation conditions or effects was given, but Lamb[4] operates the arc on cadmium alloys at 10 amp. on a 220 volt D.C. line with the lower electrode the positive. Exposure is continued to complete volatilization (about 40 sec.) of the dried 0.1 ml. solution (25 mg. metal) or until the marked abrupt change in the sound of the arc occurs. This reduces the intensity of the background spectrum until it gives little or no trouble. The zinc lines 3345.0 Å. and 3345.5 Å. are faintly visible when only 0.001 per cent of zinc is present.

Lamb also discusses the porosity or lack of it and uses the method of drying graphite electrodes suggested by Petrey[44] and finds that one of the most satisfactory methods for judging uniformity of volatilization is to observe the intensity of a sensitive spark line of the base metal. For cadmium the line 2573.04 Å is indicated or the spark line 2265.03 Å may be compared for relative intensity with the adjacent arc line 2267.47 Å. Comparison of line intensities is by visual examination as common in the "comparison sample" method whereby the unknown spectra are in juxtaposition with the standards whether solution or solid. Interpolation is preferred and extrapolation, if used with discretion, is useful but not of as high a degree of precision.

While this method involves more work, the arc spectrum of cadmium and certain other metals do not offer sufficient suitable lines for use in the "internal standard." Table V gives the zinc, lead, iron, copper, nickel and titanium lines to be used for ranges of concentration of 0.001 to 0.500 per cent. Several interfering lines are also given with notes as to alternatives. A table of lines for concentrations of magnesium 0.001 to 1.00 per cent in cadmium-base alloys is included and the several illustrations of spectral plates are notable for the evidence of close control of excitation and photographic conditions.

Fig. 2.—For a Certain Ni-Cr Alloy Currents of 10 Amperes or Above Would Be Satisfactory.



The procedure is avowedly patterned after Nitchie[32] and Fuller and Standen[33] and as now approved by the A.S.T.M.,[34, 35, 36] but detailed instructions are given as to the especial standard solutions and method of sample solution applicable to cadmium. Either 2.5 gm. in 10 ml or 10 gm. dissolved in 40 ml of concentrated nitric acid may be used.

Table V—Lines for Certain Metals

Element	In I.A.*	Range of Concentration, Per Cent	Neighboring Lines in I.A.
Zinc	3282.32	0.025-0.500	
	3302.6 3303.0	0.01 -0.500	Na—3302.94 [a]
	3345.0 3345.5	0.001-0.500	
Lead	2613.68 2614.204	0.001-0.500	Fe—2613.84 [b]
	2802.007	0.001-0.500	
	2833.069	0.001-0.500	
	2873.32	0.005-0.500	
	4057.830	0.005-0.500	
Iron	2719.036	0.001-0.500	
	2720.909	0.005-0.500	
	2723.581	0.010-0.500	
	3020.645 3021.077	0.001-0.500	
Copper	2225.68	0.10 -0.50	
	2227.76	0.10 -0.50	
	2230.09	0.10 -0.50	
	3247.548	0.001-0.500	
	3273.964	0.001-0.500	
Nickel	3101.561 3101.880	0.01 -0.500	Fe—3099.901-3100.671 [c]
	3414.77	0.001-0.500	
Thallium	2767.88	0.001-0.500	

* Wave length values taken from Tabelle der Hauptlinien Der Linienspektra Aller Elements by H. Kayser.

[a] If sodium is present in the sample the doublet at 3302.6 and 3303.0 I.A., cannot be used; however, this interference is not likely.

[b] The iron line at 2613.84 I.A. interferes with the use of the lead lines 2613.68 and 2614.203 I.A.

[c] The nickel lines at 3101.561 and 3101.880 I.A., must not be confused with the iron lines at 3099.901-3100.671.

Hall[34] first runs a preliminary plate arcing 50 mg. of lead filings with a direct current of 15 amp. and a potential of 60 to 70 volts across the arc. Exposure is for 3 min. from the moment the arc is struck. Comparison of such a plate permits selection of the proper "comparison standards," a procedure for which is described. For the regular run, 20 gms of turnings or filings from a representative sample are dissolved. The final volume should be 20 ml of nitric made up to 100 ml. Recessed graphite electrodes charged with 0.1 ml portions (= 20 mg sample) are dried at 200 deg. F. before arcing as before. Table VI lists suitable lines and concentrations for the estimation of copper, bismuth, silver and nickel in any high grade lead.

Table VI—Suitable Lines and Concentrations for Certain Metals

Element to be Determined	Wave Length in I.A. of Suitable Lines	Range of Concentration in Which Line is Useful Per Cent
Copper	2492.2 2618.4 2766.4 2961.18	0.32 to 0.04
	3247.55 3274.00	0.04 to 0.0001
Bismuth	2898.0 2989.0 2993.34 3024.64	0.256 to 0.02
	3067.73	0.02 to 0.001
Silver	3280.7 3382.9	0.128 to 0.0001
Nickel	3002.5 3003.6	0.128 to 0.001

Wave Lengths in brackets have been inserted by abstractor from Kayser's Hauptlinien.

In the foreword the sponsor rather suggests limitation of the method to amounts of impurities or minor elements less than 0.10 but states in a private communication to the abstractor that "the method would be applicable to larger amounts of impurities .0.20% and would certainly come within the range of this method and I even think it could go up to 0.50%." No mention is made of interfering lines nor of expected precision. Sensitivity appears to be of the order of 0.0001 per cent for copper, bismuth and silver and of 0.0002 per cent for nickel. Antimony and tin are not mentioned. In making regular comparison runs it is wisely recommended that the lowest standards be used first. Visual comparison is employed and extrapolation is not recommended except in testing for compliance with a specification for which a recommended procedure is also given as e.g. the so-called "Go-No Go" type of analysis.

In the method for the Quantitative Spectro-chemical Analysis of Zinc[35] and that for Zinc-base Die Cast Alloys,[36] the procedures are again of the same order—20 gm. of a representative sample of zinc are dissolved in HCl to an evaporated volume of 35 ml made up to 40 ml or 0.10 ml = 50 mg. For zinc alloys equal volumes of conc. HCl and HNO_3 are used with 20 gm. and evaporation to 50 ml and a final volume of 60 ml or 0.10 ml = 33 mg.

Table VII[35]—Wave-Lengths of Suitable Lines of Pb, Fe and Co

Elements to be Determined	Wave Lengths in I.A. of Suitable Lines	Range of Concentration in Which Line is Useful, Per Cent
Lead	2873.32	0.1 to 0.01
	2663.17	
	2833.07	0.1 to 0.0002
Iron	2845.59	0.1 to 0.05
	2727.54	
	2714.42	
	2625.67	
	3021.07	0.05 to 0.0001
	3020.5	
Cadmium	2980.62	0.1 to 0.05
	3261.05	0.05 to 0.001
	2288.00	0.002 to 0.00005

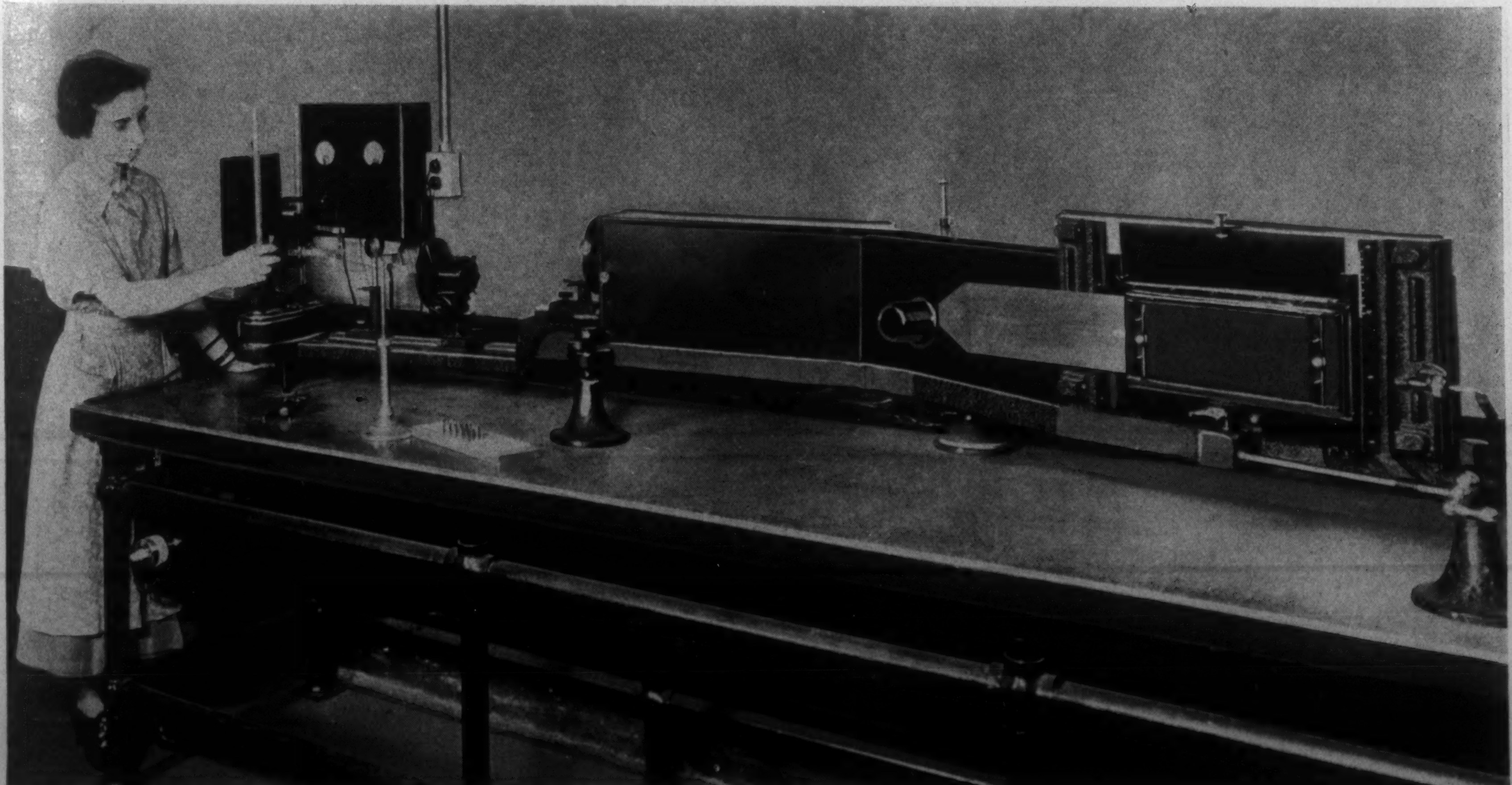
Table VIII[36]—Concentration Range and Lines for 7 Metals in Zn Alloys.

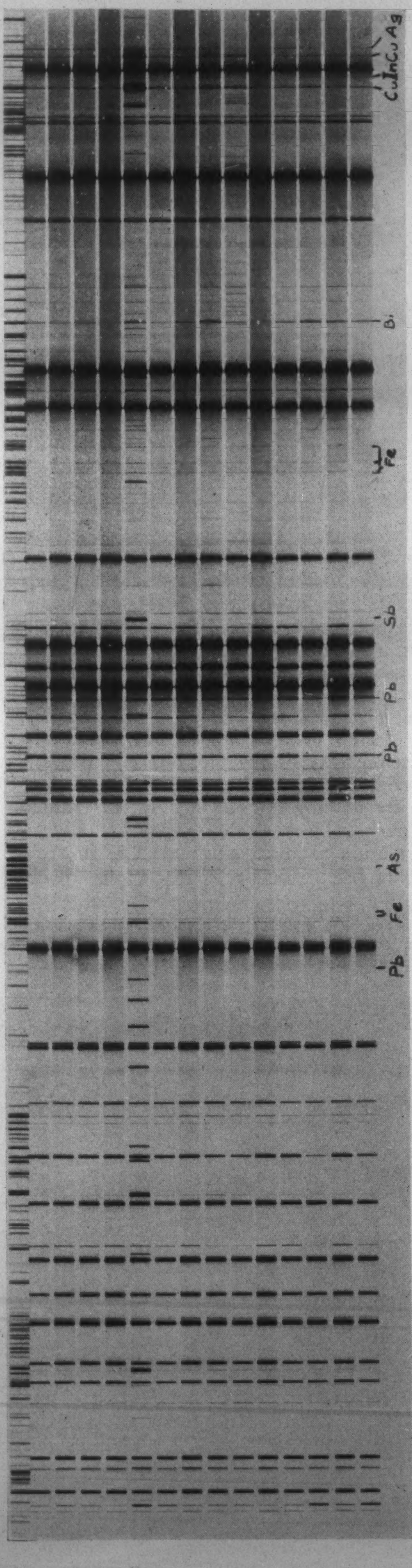
Elements to be Determined	Wave Lengths in I.A. of Suitable Lines	Range of Concentration in Which Line is Useful, Per Cent
Magnesium	2782.99	0.25 to 0.004
	2781.43	
	2779.85	
	2778.29	
	2776.71	
Nickel	3031.87	1.0 to 0.1
	2821.29	
	3057.65	0.1 to 0.008
	3054.32	
	3012.00	0.1 to 0.004
	3003.63	
Copper	2961.18	1.0 to 0.03
	2824.38	
	2618.38	
	3273.96	0.03 to 0.0005
	3247.55	
Iron	2929.01	1.0 to 0.05
	2912.16	
	2788.11	0.2 to 0.01
	2723.58	
	2720.91	0.1 to 0.008
	2719.04	0.1 to 0.002
	3020.64	0.02 to 0.0005
	3020.50	
Lead	2614.20	0.1 to 0.001
	2833.07	0.02 to 0.0004
Cadmium	3261.05	0.1 to 0.001
	2288.03	0.001 to 0.00005
Tin	2863.32	0.05 to 0.002
	2839.99	

In each case recessed 5/16-in. electrodes, prepared if need be as previously described,[29] are charged with 0.10 ml portions of either unknown or standard and dried for 30 min. at 200 deg. F. The lower electrode is the positive. C. H. Davis in discussion stated that for brass the negative seems preferable as to reproducibility but Fuller finds otherwise, particularly as to sensitivity using 80 to 100 volts across the arc with a direct current of 10 amp. with recording for 2 min. from the moment the arc is struck. Prior burning of the lower electrode for 2 min. at 10 amp. is recommended. Lamb prefers not to burn because of the change in porosity of the graphite electrode.

The sponsors recommend recessing 2-in. lengths of graphite by drilling a hole 0.15 in. in diameter and 0.25 in. deep. (Deeper craters may actually be better when oxidation products—produced as in arcing lead or tin—interfere. The deeper the crater the less loss

Dr. Frances Lamb, formerly of the department of physical chemistry, Michigan State College, who operates the spectrographic equipment in the inspection department of the Michigan Smelting & Refining Company, a subsidiary of the Bohn Aluminum & Brass Corp. The spectrograph shown here is used for routine inspection of non-ferrous metals manufactured by the Bohn Company.





Routine Spectrogram Showing the Spectrograph Examination of Pig Tin in the Laboratories of Lucius Pitkin, Inc., New York. It shows the range of the important metals in question.

by spatter and the less production of oxides, which may be of a refractory non-conducting type—Abstractor).

The limits of detection and quantitative estimation are approximately 0.0002, 0.0001 and 0.00005 per cent for lead, iron and cadmium respectively where the Littrow type instrument is used. (Sensitivity limits should really be given by weight rather than percentage or ppm.)

A "Go—No Go" procedure for tests for compliance with specifications, in addition to the standard or umpire procedure is given as well.

Table VII gives the wave-lengths (in I.A. as with the others) of suitable lines of lead, iron and cadmium in zinc and the range of concentration in which the line or group is useful. Detailed procedure is also given for the preparation of suitable standard solutions for both zinc and zinc alloys.

Table VIII gives the concentration range and lines for magnesium, nickel, copper, iron, lead, cadmium and tin in the zinc alloys.

A moderately slow fine grained plate such as Eastman 33 is best suited. A developer formula is suggested also.

Fuller[35] advises that, when illuminating the slit, a quartz lens (or lenses) be used in such a manner that the images of the electrodes be sharply defined one above, the other below the open portion of the slit to exclude the intense continuous spectrum of the hot graphite electrodes. The central portion of the slit is preferred.

Lamb uses a sector disc adjusted to allow 1/32 of the light to reach the slit but otherwise follows the outline just preceding.

Owens and Hess[7] recommend that the solid magnesium alloy electrodes be 11 by 3 mm cross-section. The length of the spark gap is maintained at 5 mm between electrodes. A 1-KVA, 25,000-volt Thordarson transformer is used. In series with the spark gap is an air core inductance of 0.00003 henry, in parallel with the gap is a capacitance of 0.00577 microfarad. This procedure gives greater reproducibility for, even when held in massive air-cooled holders, the burning of the electrodes prevents the maintenance of an arc of constant spectral characteristics. A slit width of 0.06 mm is used on the Bausch & Lomb medium instrument. No lens is used between spark source and slit and maintenance of the spark discharge for a minimum of 6 min. before exposure increased greatly the precision. Eastman polychrome plates are used.

Wolfe[15] offers a means of remedying the fogging that occurred in using their Littrow type spectrograph, due to the excessive light at times reflected from the surface of the lens. Elimination of the defect may be accomplished by changing slightly the setting of the prism, placing suitable diaphragms inside the spectrograph case or tipping the lens.

Unfortunately, great as was the value of the A.S.T.M. symposium and committee sessions, the discussion was not available at the time of abstracting. but all will be collected together under one cover as a separate A.S.T.M. publication later on and will, of course, appear in the *Proceedings*.

Summing up, the quartz spectrograph is used by all the authors taking part in the proceedings at Detroit, some being equipped with the intermediate and some with the large or Littrow type or both. Apparently the grating spectrograph has made little progress as yet outside the use of the large ones in institutional physics departments and the small one for student purposes.

Controlled Atmospheres in Steel Treating—III

A Correlated Abstract

By H. W. GILLETT

Editorial Director of METALS & ALLOYS *and Chief Technical Advisor, Battelle Memorial Institute, Columbus, Ohio.*

THIS COMPREHENSIVE CORRELATED abstract is discussed in four parts: Part I was largely introductory, dealing with the character of the usable gases. Part II dealt with the cost and action of different usable gases. In the August issue all of Part I and a portion of Part II were published. In the September issue the remainder of Part II and all of Part III—"Furnaces in Which to Apply Controlled Atmospheres"—were published. Part IV, which has as its title "Correlation of Experiments and Experiences," is offered in part in this issue (October) and will be concluded in the November number.—EDITOR.

Part IV—Correlation of Experiments and Experiences

IN attempting to correlate the experiments and experiences on record as to atmosphere control, it will be convenient to divide the subject into scaling and its avoidance, decarburization, and carburization.

Scaling

THE scaling of steel has been discussed by Pilling and Bedworth[58], Schroeder[59], Heindlhofer and Larsen[16], Whiteley[5] and Stein[60], in great detail at the University of Michigan by Jominy and Murphy[6], Murphy, Wood and Jominy[61], Upthegrove and Murphy[62], Upthegrove[63] and Siebert and Upthegrove[64]. Pfeil[65] has discussed both the formation and the constitution of scale, and Griffiths[66] has discussed blistering.

The British Department of Scientific and Industrial Research has in press a "Review of Oxidation and Scaling of Heated Solid Metals" which, when available, should give a comprehensive summary of available knowledge in this field.

These discussions deal in considerable detail with the scaling and scale resisting properties of alloy steels, a matter which we have excluded from the scope of the present review. Nor do we need to discuss the controversy as to a decreased rate of scaling in a certain very high temperature range, as we are dealing with the problem of elimination of scaling.

All workers agree that the presence of SO_2 materially increases the rate of scale formation.

Upthegrove[63] brings out clearly that at forging temperatures not only the absence of any O_2, but the presence of so much CO is required to balance the CO_2 and H_2O in a flue gas atmosphere that it is quite out of the question to avoid scaling and still get economical combustion, while at 1700 deg. F. it takes but 3 per cent CO to cut the scaling by 75 per cent. However, if decarburization is likewise to be prevented, this cutting down of the rate of scaling may not be at all a satisfactory solution, for a very much higher CO content is required to avoid decarburization, as Fig. 13 [Part I] shows. Upthegrove's summary is very informative as to the effect of carbon content on scaling.

Eilender[22] assembles data which lead to the conclusion that the scale formed in air is of a different type, and less pervious, than that formed in CO_2 or H_2O vapor, for the rate of scale formation decreases with time in air while it continues to form at a more uniform rate in CO_2 or H_2O. When these gases are sufficiently diluted with N_2, however, the rate decreases with time.

He also concludes that, broadly speaking, the decarburization of steel (at temperatures in the gamma field) increases linearly with temperature but at any one temperature tends to fall off after an initial period. This is of course dependent on the rate of diffusion of carbon. The problem of decarburization seems more complex than that of scaling.

Since CO_2 and water vapor, as well as free oxygen, are oxidizing, steel exposed to the products of combustion of fuel that is burnt with sufficient air for complete combustion and high thermal efficiency, will scale. By sacrificing complete combustion and operating with a reducing atmosphere, the rate of scaling can be somewhat reduced, especially in the annealing temperature range but scaling cannot thus be completely eliminated.

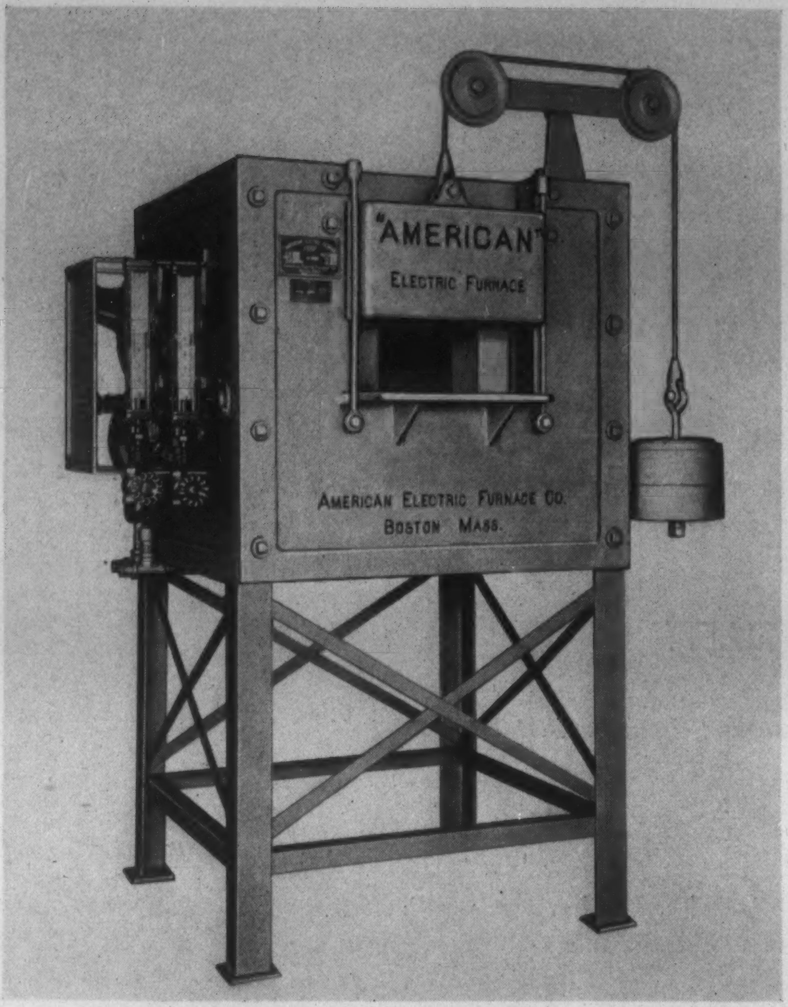


Fig. 36. A Globar-Equipped Furnace Provided with Proportioning Valves and Gages for the Injection of a Controlled Gas:Air Mixture.

Using a Deficiency of Air

Many of the workers in this field have dealt with the question of using a deficiency of air in the combustion of fuel in a furnace in which the products of combustion meet the work. Schroeder[59] comments that the cost of scaling, on the basis of weight loss and value of the charge, may be greater than the cost of the fuel for heating.

Blackburn and Cobb[67] pointed out that a smoky atmosphere in itself is no assurance that scaling will be prevented. They considered the feeding of a reducing gas into a furnace to mix with the products of combustion of the fuel used for heating in order to overcome scaling. But experiments on addition of either H_2 or CO to an atmosphere containing 18 per cent CO_2 and 2 per cent H_2O vapor from the combustion of coke indicated that it would cost as much to supply the necessary volume of reducing gas as the cost of the fuel itself. They concluded that water vapor was a chief culprit, and since hydrocarbon fuels produce much water vapor because of their hydrogen content (coal gas burning on complete combustion, to a gas with 22 per cent water vapor and oil to one with 13 per cent), advocated the use of fuel rich in carbon and low in hydrogen, such as high temperature coke in a producer without steam.

Percival[68] also notes that scaling in a N_2-CO_2-H_2O atmosphere increases with the water vapor, and that wet H_2, always present in products of combustion of gases burned with a deficiency of air, is the most powerful decarburizer, so that in producing a balanced atmosphere the key is the removal of water vapor.

Mere reduction in thickness of the scale produced may not be much of a step in the right direction, for Rheinländer[69] finds that, if the atmosphere is not sufficiently oxidizing, the scale that is produced may not come off freely, which is in agreement with Eilender[22] who has recently reviewed a good deal of the previous work in this field. Among his general conclusions are that the products of combustion (with combustion complete enough for heating the charge) of ordinary fuels exert both a scaling and a decarburizing action; that in annealing prior to cold working it is best practice to use a rather strongly oxidizing atmosphere so that a type of scale will be produced that will "jump off" in pickling without leaving a decarburized layer on the surface; and that the phenomenon of simultaneous scaling and decarburization is connected with the relative rate of oxidation at the surface, that of diffusion of a decarburizing component of the gas through the scale and the metal and that of diffusion of carbon in the metal. Thus, at lower temperatures where the rate of scale formation is insufficient, oxidation may not keep pace with decarburization so that the layer of scale may be underlain by a decarburized layer. This phenomenon is especially noticeable in the presence of water vapor.

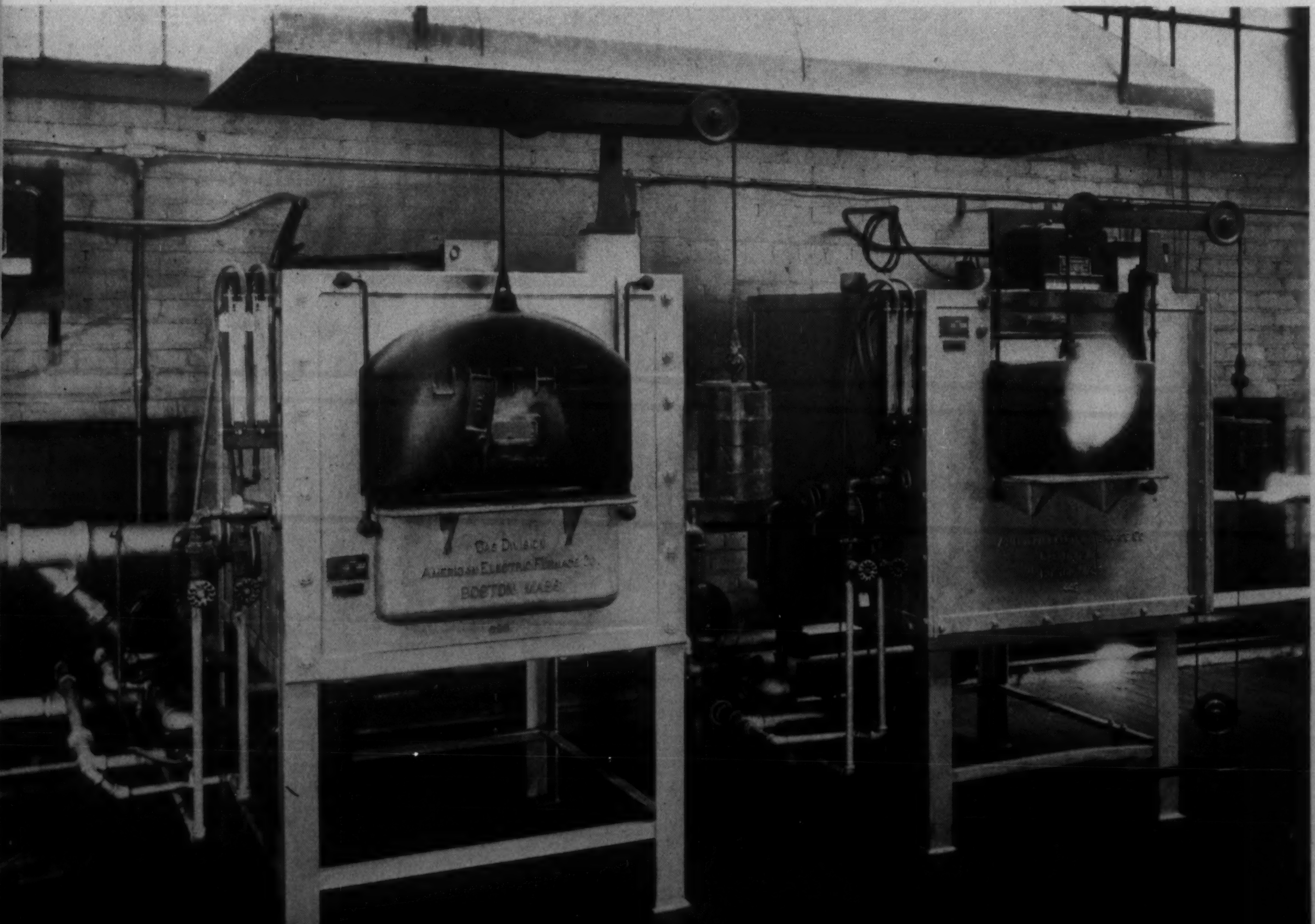


Fig. 37. Gas-Fired Furnaces, made by American Electric Furnace Co., with Proportioning Valves Similar to Those Shown in Fig. 36.

Cobb and coworkers[67] have examined the scaling of a 0.20 per cent carbon steel in various atmospheres in 3 hr. exposure at 1000 deg. C. They used air, CO_2, CO_2-H_2O, N_2, H_2O-H_2, CO_2-H_2, H_2O-CO, and CO_2-CO. When H_2 was present, initially or as a reaction product, and its amount was increased sufficiently to prevent scaling, decarburization was met. In the CO_2-CO series, with the gas carefully dried, scaling ceased and decarburization began when the gas contained more than about 60 per cent CO, and carburization began when the CO content rose above 85 per cent.

Blank runs in very carefully dried N_2, containing only about 0.01 per cent O_2, showed no oxidation or tarnish, but the surface became matte and there was slight decarburization. The authors considered that a carbon-less iron would have been oxidized, and that the behavior was due to the presence of carbon in the steel.

Scott[70] long ago noted that on heating a 0.86 per cent C steel in air, for different times and temperatures so that the same amount of scale was produced in each case, decarburization increased with temperature. Below 1550 deg. F. and up to 5 hr., scaling kept pace with decarburization.

Bramley and Allen[71] paid particular attention to the rate of diffusion of carbon in steel, since this rate is of importance in comparison with the rate of oxidation.

Trinks[72] points out that the 15 per cent CO found necessary by Jominy[17] for the elimination of scaling requires a large excess of fuel and that most industrial furnaces operate with only 1 to 4 per cent CO. He also points out that in heating packs of sheets for hot rolling a little water vapor is desired to produce a thin magnetic oxide that will keep the sheets from sticking.

In order to prevent scaling of the outside of annealing boxes operating at 1200 deg. F., one company adjusts the burners so that the atmosphere contains only ½ per cent CO, for operating with higher CO produces soot and lowers thermal efficiency.

Furnaces for heating sheet bar, operating at 1700 deg. F. are run with 2 per cent CO in the flue gas, this producing but little scale and that easily brushed off.

Little attempt has been made to provide controlled atmospheres for high temperature furnaces for heating for forging and the like. The isolation of the work from the source of heat from fuel so as to confine the controlled atmosphere and at the same time secure rapid and efficient heating is not easy because of the size of large forgings and the high temperature.

Electric forging furnaces, in which the atmosphere might be controlled more easily, would, because of the temperature involved, have to be of the Globar, carbon resistor or arc types, and so far there seems to be small commercial use of electric heat for this purpose, though the matter has been the subject of considerable thought and experiment.

Decarburization

DECARBURIZATION can occur in atmospheres high in H_2 or CO that are non-oxidizing to iron, or even reducing to FeO by reaction with Fe_3C, for, if in an atmosphere oxidizing to iron the attack upon the iron goes on more slowly than the simultaneous decarburizing attack on Fe_3C, both scaling and decarburization may occur. Hydrogen can diffuse into the metal and decarburize it below the surface. Unless the diffusion of Fe_3C from the body of the steel to its surface goes on rapidly enough to compensate for the loss at and near the surface, a soft skin will result. Hence the rate of diffusion of Fe_3C, which is quite different in different steels, and very dependent upon temperature, needs to be considered as well as the chemical reactions involved. It is the diffusion rate that introduces so great a variable that the tendency of an alloy steel toward decarburization is hard to predict without experiment.

If the temperature is not too high or the time in the furnace too long, when oxidation is proceeding, the metal beneath the scale produced in air may be unchanged in composition, and not decarburized, but, especially in a flue gas atmosphere high in water vapor or in CO_2, there may be a decarburized skin beneath the scale, fatal to good tool performance unless the soft skin is ground off.

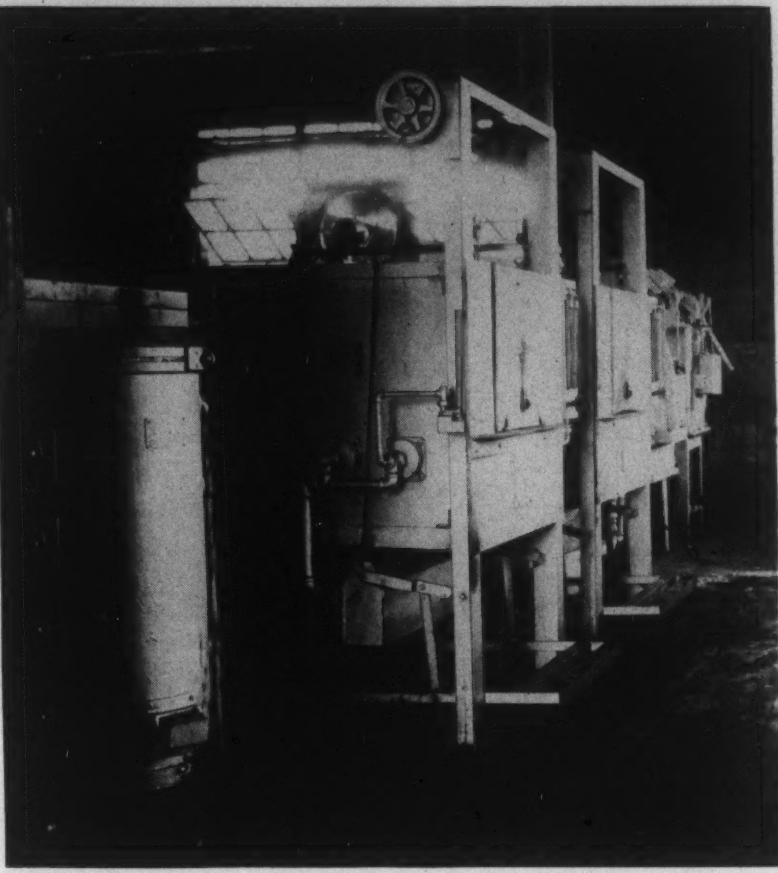


Fig. 38. Controlled Atmosphere Furnaces for Preheating and for Hardening Carbon and High Speed Tools at the Lindberg Steel Treating Co. These are Surface Combustion Co. gas-fired furnaces with silicon carbide muffles. The atmospheres are obtained by pre-burning gas with air in controlled proportions in separate chambers.

Richardson[73] has stated that decarburization was the bane of the Roman tool maker, and that the retention of hardness, or its restoration to a cutting edge, was a most difficult problem. He quotes Diodorus as stating that the Celtiberians buried plates of steel underground till the surface had rusted away, and then made swords and other tools from the remaining, stronger, part. The present day toolmaker has just as strong objections to a soft skin as had his Roman predecessor.

If we seek to avoid scaling on high-carbon tool steel and at the same time need to avoid decarburization we have to be very careful how we proceed in shifting the gas composition from the oxidizing to the reducing side. Schultz and Hülzbruck[19], and Curran and Williams[74] as well as Jominy[17] have dealt with this in detail.

Decarburization of High-Speed Steel

Considerable discussion has been given to atmospheres for hardening high-speed steel to avoid decarburization. One device is to use a carbonaceous muffle within which the work is placed the entering air causing slow combustion of the muffle interior and thus

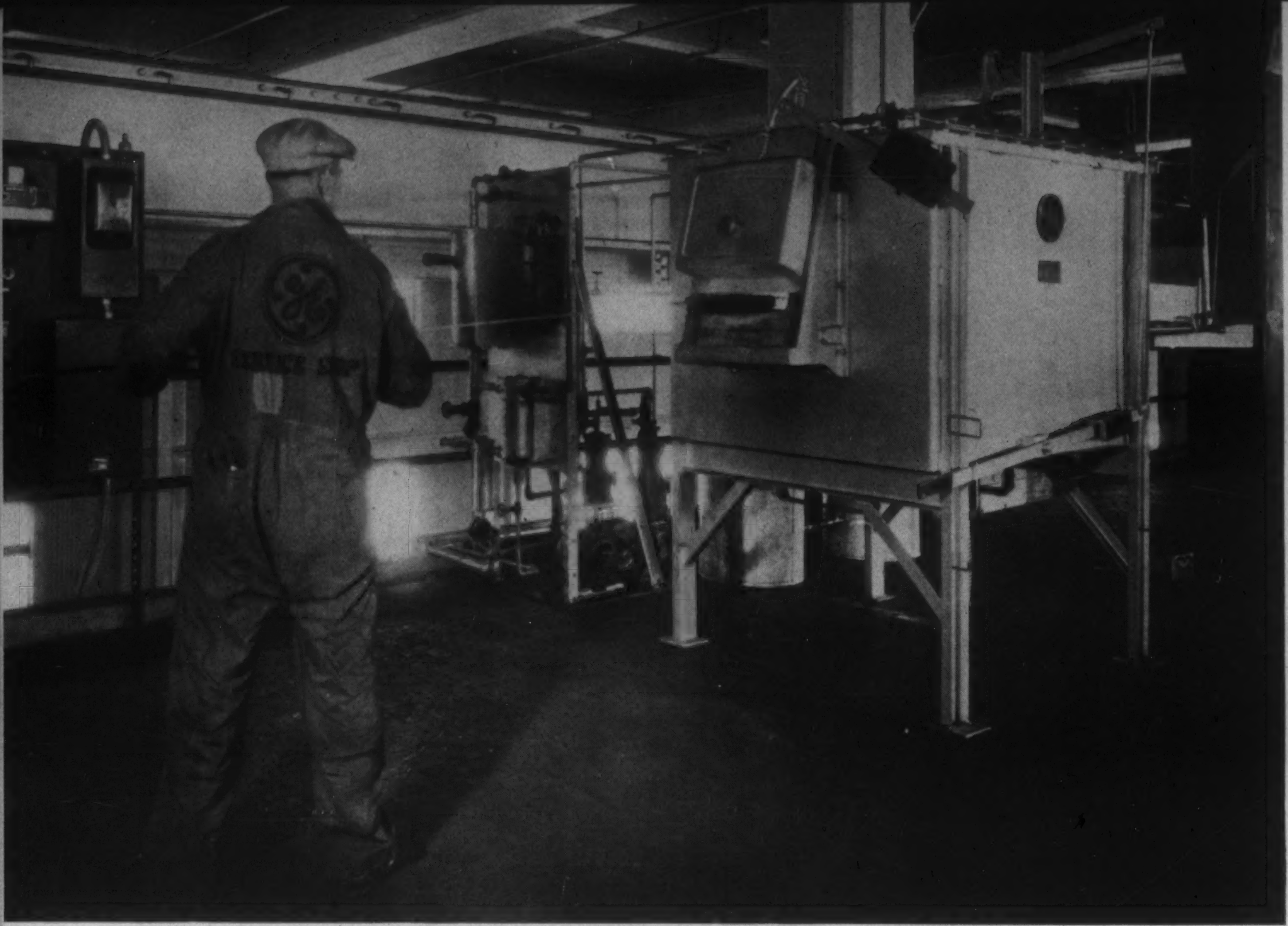


Fig. 39. Gas Generating and Drying Equipment for Controlled Atmosphere, and Furnace to Which it is Fed. G.E. make.

providing a N_2-CO-CO_2 atmosphere which remains more or less stagnant within the muffle. Such an atmosphere at high-speed steel hardening temperatures will be, as Fig. 13 indicates, high in CO and low in CO_2 and should have a carburizing tendency. It is claimed that even molybdenum high-speed steel, which is sensitive to decarburization, can be hardened in such muffles without scale or decarburization.

Some observers point out that a carburizing atmosphere can be used for some tool steels, while other steels, particularly in large sizes that require high temperatures and long soaking, carburize too much.

Tour[75] points out that, from the point of view of the tool hardener, a "neutral atmosphere" is one that gives practically no scale and no decarburization, so he advocates, for tool work, controlling the furnace atmosphere produced by burning gas and air so as to contain 4 per cent free oxygen at 1500 deg. F. and progressively reducing the oxygen at higher temperatures, to 2.5 per cent at 1600 deg F., in preheating highspeed steel, to zero oxygen and 1½ per cent CO at 2300 deg. F., and 10 per cent CO at 2400 deg. F. With the corresponding CO_2 all these would be classed as oxidizing, and should at least produce a thin scale. Others also find such atmospheres satisfactory.

Esslinger[76] prefers a slightly oxidizing atmosphere for the preheat, aiming to produce a very thin, adherent scale and to use so strongly reducing an atmosphere in the final, short time, heating at 2300 deg. F. that the scale is reduced to metal.

H. A. Clark (personal communication) likes an atmosphere with about 4 per cent CO for preheating and 13 per cent for hardening high-speed steel. E. F. Burke (personal communication) desires 2 per cent O_2 at the 1450 deg. F. preheat for 18:4:1 and 6 to 10 per cent CO at the high heat, and remarks that lower CO will promote blistering unless the time is very short. The actual analysis of the atmosphere will depend on the particular gas used and other local conditions.

Kjerrman and Bohm[77] reverse this procedure for carbon and alloy steels, hardened at lower temperatures than high-speed steel, in hardening furnaces in which the products of combustion meet the work and for problems where slight scaling is, but a soft skin is not, permissible. A reducing flame is used through most of the heat, but for the final 5 or 10 min., it is made oxidizing so that the layer that has previously been decarburized is oxidized and removed as scale. Not only was this found to produce better quality in that the work was free from soft skin, but by avoiding the excess air used in the former practice of running oxidizing all the time, the fuel consumption was reduced. In a continuous furnace the atmosphere over the incoming work is held reducing, but at the exit end an oxidizing atmosphere is maintained.

Burke (personal communication) finds that in hardening ornate engraving dies it is best to reverse Kjerrman and Bohm's practice, preheating in a definitely oxidizing atmosphere up to 1000 deg. F. and then quickly bring it to quenching temperature in an atmosphere high in CO, else the high-heat scaling will ruin the design.

H. B. Chambers (personal communication) reports that intermittent variation of the atmosphere can be utilized to secure freedom from either carburization or decarburization when annealing plain carbon, high speed, or 2 per cent C, 12 per cent Cr steel for long periods up to 1650 deg. F. in a pit type electric furnace. Natural gas or city gas is run in at intervals, the intervals depending on the gas used, the steel, the tightness of the furnace and the temperature, and being determined by experiment with test pieces.

Oliver[42] records experience in handling high-speed steel in the same type of furnace equipment and with the furnace atmosphere (according to gas analyses for O_2, CO_2 and CO), made the same as those used by Tour. He got appreciable scaling. Varying the atmosphere analysis to duplicate that which was giving freedom from scaling and decarburization at Cleveland, he got both scaling and decarburization. Finally, by adjusting the atmosphere without regard to the experience of others, he too was able to get a satisfactory surface. His data are summarized in the Table which shows that the city gas used by Tour and the Cleveland natural gas differed from the Dayton natural gas.

Hence the moisture content of the atmosphere varied in the three cases and the gas analyses did not include moisture content.

Table of Summation of Data on High-Speed Steel

	Pre-Heat, 1600 deg. F.			Hardening Heat, 2300 to 2350 deg. F.			Gas Supplied at Burner, Per Cent		Remarks
Per Cent	O_2	CO_2	CO	O_2	CO_2	CO			
S. Tour, New York	3.00	11.8	0.00	0.00	8.2	5.1	H_2 CO CO_2 O_2 N_2 C_2H_4 Illum.	36 17.4 3.4 0.3 12.0 24.9 5.2	Surface O.K. Grain size fine.
Cleveland, Ohio	0.00	7.00	1.00	0.00	5.00	8.00	C_2H_4 C_2H_6 N_2	83.4 15.8 0.8	Surface O.K.
Dayton, Ohio	0.00	2.5	12.5	0.00	3.40	9.20	C_2H_4 C_2H_6 CO_2 N_2	92.5 5.0 1.0 0.8	Surface O.K.

High-Speed Steel in Different Atmospheres

Tour[78] has elsewhere discussed the problem of the behavior of high-speed tool steel when heated in different atmospheres, and has claimed that grain growth, such as would occur in a very short period of heating in air at 2300 deg. F., does not occur in his controlled atmosphere even after quite extended heating.

Some of his explanations provoked considerable discussion, and several points of view were put forth as to the exact causes of the phenomena noted, Keshian in discussion suggested that in air the temperature of the piece was raised by oxidation while, in an atmosphere containing considerable CO, the temperature of the piece lagged behind that of the furnace. J. E. Hines (personal communication) states that, in experiments carried out to test, this suggestion was found to be the case. Gill[79] comments that the atmosphere may be made so oxidizing that the heat of combustion raises the temperature of the piece, or it may be adjusted to carburize the piece, or to leave it unaffected. For the 18-4-1 or 18-4-2 types heated to 2300 to 2400 deg. F., Gill prefers 6 to 8 per cent CO_2 and 5 to 7 per cent CO as having the least action on the steel.

Other users put the preferred gas composition at 10 per cent CO, 4 per cent CO_2. Gill denies that the atmosphere itself has any effect on structure so long as it does not change the actual composition by carburizing or decarburizing, and believes that structure is affected by changes in composition or by change in temperature due to surface oxidation.

Hines[80] states that a shrinkage in dimensions is noted in high-speed steel on hardening in atmospheres containing free O_2 which seems too large to be accounted for by any mere surface reaction.

The high-speed steel hardening atmospheres employed in the type of furnace used by Tour in which the products of combustion from a gas flame, fed with a controlled ratio of gas and air, seem to be generally adjusted by users so as to be free from oxygen, so that wood will char but not burn in the furnace chamber. Entrance of air to the chamber is hindered by a curtain of burning gas. Inappreciable scaling and good freedom from decarburization seems to be attainable in these furnaces.

An outfit for high-speed steel hardening, applicable also to lower temperature uses, transmits the heat from gas flames through a silicon carbide muffle, the muffle

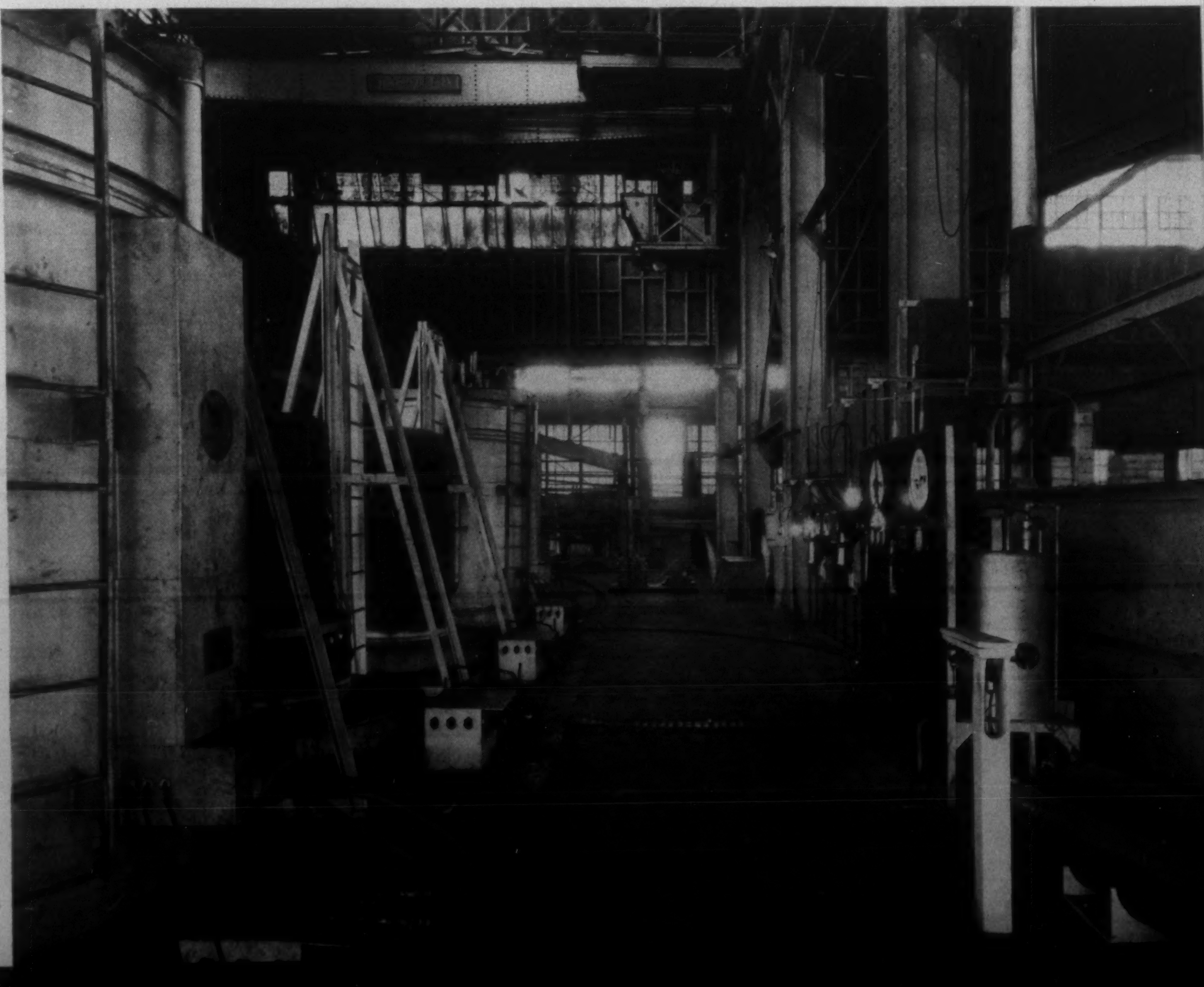


Fig. 40. Bell Type Furnaces and Equipment for Producing the Controlled Atmosphere, for Bright Spheroidizing Annealing of High-Carbon Coiled Wire and Strip. Westinghouse.

being fed with partly burnt gas made in an auxiliary outfit from suitable hydrocarbon gas (in one case mixed natural and city gas) and a regulated deficiency of air. This, of course, utilizes the CO_2:CO and H_2O:H_2 equilibria. The equipment is said to handle "Motung" without decarburization. The exact atmosphere used has not been stated.

For 0.40 per cent C or high-carbon tool steel many observers seem to agree that the atmosphere should produce a thin oxide film. Several commentors state that with such steels there is no middle ground, one either gets some scale or a decarburized skin. Since a soft skin is normally to be avoided, the aim is to produce an oxide film, but to keep it as thin as possible. This idea has, as previously stated, been utilized by Kjerrman and Bohm[77].

Hardening Spring and Carbon Steels

Owen[57] has described a very elaborate furnace for hardening 0.50 per cent C spring steel at 1500 to 1600 deg. F. and refers to the atmosphere, produced by partial combustion of city gas, followed by dehydration as "neutral." In order to avoid decarburization, which would be highly disadvantageous on springs, it seems probable that such furnaces will actually be operated to give a very tiny scale on the work, or else weakly carburizing. The decarburizing zone of gas mixtures must be avoided. For heating carbon tool steel for quenching, some authorities prefer to use an atmosphere of partly burnt city gas which is adjusted to contain 1 to 2 per cent O_2, and has tne moisture largely removed.

J. A. Dow (personal communication) reports that a 0.60 per cent C steel at 1500 deg. F. showed no decarburization in an atmosphere containing 27 per cent H_2, 0.5 per cent H_2O, 17 per cent CO, 2 per cent CO_2 and 7 per cent CH_4. He believes the CH_4, which does not break down rapidly at this temperature, is practically inert.

Oliver[42] suggests, for hardening carbon steels of 0.30 to 0.45 per cent C and for carbon tool steels, a semi-continuous furnace with several temperature zones, provided with muffles through which the work is intermittently pushed, being preheated in the low temperature zone and finally brought to the quenching temperature. He suggests introducing, as the controlled atmosphere, air plus raw natural gas in such proportions that (aside from moisture) at the entering end it contains 0.6 per cent CO, 0.8 per cent CO_2, balance CH_4 and H_2. The CO:CO_2 ratio shifts toward higher CO at the high-temperature exit end. The atmosphere would appear to be a carburizing one.

Another type of hardening furnace for carbon tool and die steel uses the vapor of oil, cracked in a separate unit operated at about 1475 deg. F., which vapor is used to flush out air and which is thought to produce with the air in the furnace a slightly carburizing atmosphere. The exit gas, after passing through the furnace, is ignited at the exhaust port. One would expect that, if no air were added, the cracking would bring the gas to some approach to $CH_4 + H_4$ so that this method would utilize the left hand curve of Fig. 13. Obviously there will be no scaling, and if the H_2 content is not too high for the temperature, the action will be carburizing rather than decarburizing. Very similar arrangements may be used for actual gas carburizing, but in such use carbon is intentionally allowed to deposit on the work rather than to be thrown out as much as possible in the previous cracking unit. The metallic resistor furnaces used can operate up to 1800 deg. F., the resistors being kept out of the furnace atmosphere by providing a gas-tight retort oven closure for the work. This type is not applicable to high-speed steel hardening because of temperature limitations.

Oliver[42] mentions an atmosphere so produced which ran around 27 per cent CO, 11 per cent H_2, moisture not stated. He comments that 0.2 per cent CO_2 will produce very deep decarburization and appraises the method as difficult to control.

The heating for quenching of lower carbon steel—below 0.35 per cent—is ordinarily attended with somewhat less difficulty in providing a suitable atmosphere than is the case with the higher carbon and tool steels, because decarburization proceeds less rapidly and a little may do no harm, so if the atmosphere wanders a bit over on the decarburizing side, less damage is done. Similarly, a little carburization might not affect the performance appreciably.

(To be continued)

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ORE CONCENTRATION (1)

Crushing, Grinding & Plant Handling (1a)
Gravity Concentration (1b)
Flotation (1c)
Magnetic Separation (1d)
Amalgamation, Cyanidation & Leaching (1e)

ORE REDUCTION (2)

Non-Ferrous (2a)
Ferrous (2b)

MELTING, REFINING AND CASTING (3)

Non-Ferrous (3a)
Ferrous (3b)

WORKING (4)

Rolling (4a)
Forging & Extruding (4b)
Cold Working, including Shearing, Punching, Drawing & Stamping (4c)
Machining (4d)

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Annealing (5a)
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INDUSTRY'S MOST
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1. ORE CONCENTRATION

JOHN ATTWOOD, SECTION EDITOR

Electrical Properties of Mineral Aggregates. I. Natural and Artificial Aggregates of Crystallized Lead Sulphide. R. S. DEAN & JOHN KOSTER. *Progress Reports—Metallurgical Division. 10. Mineral Physics Studies. United States Bureau of Mines, Report of Investigations* No. 3268, Feb. 1935, pages 21-50. Massive crystalline galena has a normal positive temperature coefficient of resistance; fine grained steel galena has a negative temperature coefficient. Ballistic and a. c. bridge measurements show that steel galena behaves somewhat like a leaky condenser. In determining the cause of erratic results of a.c. resistance measurements it was observed that the measured resistance was a function of the current through the specimen. The d.c. resistance is proportional to the square of a superimposed radio-frequency current and independent of the frequency. The influence of grain size on the voltage-current characteristics at various temperatures on synthetic galena pastilles was studied. Volts vs. amps. curves are linear for all sizes and temperatures. They have an intercept which is a linear function of the temperature. The slopes of these curves are exponential functions of the temperature and give rise to a negative temperature coefficient of resistance. The values of the constants in the fundamental equation of resistance for any given mineral aggregate permit a quantitative estimate of the size of unit crystals. This is of importance where valuable impurities are deposited along secondary structures (auriferous pyrite). Also, since the sharp variation in electron density at the contact between metallic grains theoretically should give rise to a hysteresis effect in an alternating electrostatic field, the data can be applied to electrostatic separation. AHE (1)

Gold Ore from Alcona Gold Mines, Ltd., at Alcona, Ontario. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 151-156. Cyanidation, amalgamation and concentration tests were made on an ore analyzing Au 2.94 oz., Ag 0.01 oz./ton, Cu 0.43, Pb 3.10, Zn 0.50, Fe 5.10 and S 5.00%. About 20% of the Au is recovered by amalgamation, 10-15% by cyanidation with high consumption of KCN and CaO, and 86% by flotation at 6:1 or 7:1. Flotation tailings assay 0.5 oz. Au/ton and cannot be reduced appreciably by amalgamation or cyanidation. AHE (1)

Applied Mineral Physics. R. S. DEAN. *Progress Reports-Metallurgical Division. 10. Mineral Physics Studies. United States Bureau of Mines, Report of Investigations* No. 3268, Feb. 1935, pages 5-9. The theoretical background of mineral physics and some of the practical applications of these theories are discussed. In minerals, the properties are in a considerable measure determined by the extent of the interfacial area. AHE (1)

1b. Gravity Concentration

Use of Suspensions in Ore Dressing. L. A. ROSE. *Mining & Metallurgy,* Vol. 16, Mar. 1935, pages 125-126. Best method of separating Cu-rich part from almost barren rock of Cu formations at fairly coarse sizes in standard ore dressing machines seems to be the use of a medium heavier than H_2O. Fine heavy solids suspended in water increase ratio of effective weights and make separation much more efficient. They also make it possible to separate minerals and sizes that cannot be separated without their use. A wide choice of material such as galena, magnetite, hematite, barite and sand is available for forming the suspension. Estimated cost of separation is between 5 and 10 cents/ton. Included is a flow sheet of test plant and a table giving tests of suspensions in a Woodbury jig. VSP (1b)

Mechanical Classifiers in Ore Dressing (Mekaniska sorteringsapparaters användbarhet inom järnmalmsanrikningen). GUST G. BRING. *Jernkontorets Annaler,* Vol. 119, Jan. 1935, pages 1-28. Laboratory tests show that Dorr classifiers with an overflow of 125-200 mm. may be used for treating heavy minerals such as iron ores. If the classified product is treated on magnetic separators, a poor concentrate is obtained because large masses of coarse, mixed, low-density grains go to the overflow. This is due to the magnetite they contain. Sieves are preferable in this special case. Even grinding to great fineness in open circuit ball or tube mills will produce a better concentrate than grinding in a closed circuit with classifiers. With ore of fineness,—100% through 0.4 and 0.2 mm.,—the Fe contents were respectively 68.5 and 69.4% for tube mills and 66.6 and 67.3% for classifiers. HCD (1b)

1c. Flotation

Flotation of Witwatersrand Ore Products (Laboratory Results). ANDREW KING. *Journal of Chemical, Metallurgical & Mining Society of South Africa,* Vol. 35, Nov. 1934, pages 136-155. Tailings from flotation of original sand and residue were too high grade to discard without cyanidation. Reagents used were K ethyl xanthate and pine oil. The concentrates must be ground very fine for good extractions. Results from different ores varied widely. Residue from ordinary cyanide leaching contained 17.3% of the original Au; flotation of the original sand and cyanidation of the tailings left 6.34% of the Au. AHE (1c)

The Rhodesian Copper Belt and the N'Kana Mine. H. S. MUNROE. *Mining & Metallurgical Society of America, Bulletin* No. 230, Vol. 27, Sept. 1934, pages 65-72. Milling and smelting practice are reviewed. The rougher flotation concentrate runs about 40% Cu and the final concentrate 52-54% Cu, 5-7% insoluble. Heads contain 3.8% Cu and tailings 0.3%. The mill circuit is kept alkaline with 1½ lbs. slacked lime/ton. Other reagents are amyl xanthate, cresylic acid, Na_2SO_4, and pine oil. The concentrate is a balanced charge for the furnace. The converter slag contains up to 15% Co which is recovered in an electric arc furnace. AHE (1c)

The Wetting Characteristics of Galena. F. E. BARTELL & GEORGE B. HATSCH. *Journal of Physical Chemistry,* Vol. 39, Jan. 1935, pages 11-23. The disagreeing previous determinations of the angle of contact of water on galena are pointed out. A study of the methods of measuring contact angles has been made. (A) The pressure of displacement method gives duplicable and significant results. It is the only method suitable for use with powdered materials. (B) The horizontal plate method as generally employed is unsuitable for substances which give dual contact angles. (C) The vertical rod method appears to give reliable results with those substances which will give clean smooth surfaces of proper shape. (D) The deposited film method is primarily suited for the determination of angles of contact upon pure materials, films of which can be found by sublimation. This method offers greatest possibilities in fundamental studies of pure and uncontaminated surfaces. Results obtained with (C) and (D) indicated that the galena-water-air advancing angle is one of 90° and that the receding angle is 0. Results using powdered galena and (A) showed that the surface of the powdered galena used was less organophilic than was that of the freshly cleaved or sublimed galena used with (C) and (D). By heat treatment the galena used in (C) could be caused to approach in surface properties the powdered galena due to oxidation. Galena has surface properties quite different from C and SiO_2 in that it functions either as an organophilic or as a hydrophilic solid depending upon whether it is first wetted by an organic liquid or by water. EF (1c)

1d. Magnetic Separation

Magnetic Properties of Mineral Powders and Their Significance. C. W. DAVIS. *Progress Reports—Metallurgical Division. 10. Mineral Physics Studies. United States Bureau of Mines, Report of Investigations* No. 3268, Feb. 1935, pages 91-100. The significance of magnetic properties (as displayed by hysteresis loops) and their relation to chemical composition are discussed for natural and treated minerals. High coercive force and remanence are characteristic of ferric oxide formed by dehydration of lepidocrocite and of several ferrites produced under conditions favorable to the development of large interfacial area. The high coercive force and remanence of lodestones differing widely in chemical composition may be simulated by reduction of Fe_2O_3, by the reaction between finely divided oxides to form ferrites, or by the heat treatment of titaniferous Fe_3O_4. The relation between magnetic properties and magnetic separation is discussed. AHE (1d)

Magnetization Curves for Magnetite Powders. V. H. GOTTSCHALK & F. S. WARTMAN. *Progress Reports—Metallurgical Division. 10. Mineral Physics Studies. United States Bureau of Mines, Report of Investigations* No. 3268, Feb. 1935, pages 67-81. Magnetic permeability of various sizes of powdered magnetite from Hurley, N. M.; Mineville, N. Y.; Ural Mts.; and slag from the bottom of a Cu reverberatory furnace at Hayden, Ariz., measured at $H = 30$ and $\delta = 2.00$ showed that permeability and hence magnetization of magnetite powders is a function of the specific surface of the powder. Measurements of the Ural magnetite in 7 sizes from 3.5 μ (av.) to 180 μ (av.) were made at 19 field strengths from 13.8 to 2675 oersteds, and of 10 sizes (4.2-134 μ) of Hayden slag magnetite at 13 field strengths from 30 to 2700 oersteds. Data are given on 7 packing densities (0.63-3.41 g. $Fe_3O_4/cm.^3$) at 19 field strengths (10-2700 oersteds) for Hayden magnetite. As grain size decreases the field strength at which maximum permeability occurs increases. Packing density does not affect the position of maximum permeability, although it does affect greatly the absolute value. The variation of magnetization density with packing density is linear for high fields down to 1500 oersteds (possibly less) but for smaller fields the plot is curved, although linear or nearly so from 1.8 to 3.0 g. $Fe_2O_4/cm.^3$ AHE (1d)

1e. Amalgamation, Cyanidation & Leaching

Gold Ore from Little Long Lac Gold Mines, Ltd., Bankfield, Ontario. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 122-126. A quartz ore containing 2.35 oz. Au/ton and a schist containing 0.84 oz. Au were treated by cyanidation, amalgamation, blanket concentration and flotation. Best results were obtained by straight cyanidation of —48 mesh ore, i.e., 94.7% recovery of the Au in the quartz ore and 85.7% of the Au in the schist. AHE (1e)

High-grade Gold Ore from Swayze-Denyes Gold Area, Northern Ontario. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 136-139. Straight-barrel amalgamation of an ore containing Au 18.25 oz. and Ag 3.08 oz./ton gave recoveries up to 97% of the Au and 95% of the Ag. Tailings can be cyanided. AHE (1e)

Gold Ore and Mill Tailing from Parkhill Gold Mines, Ltd., Wawa, Ontario. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 140-142. Ore ground to —200 mesh and containing Au 1.14 oz./ton was agitated for 12, 24, 36, 48 and 72 hrs. with 1.0 lb. KCN/ton with extractions of 95.6, 96.9, 96.5, 94.3 and 96.9% respectively, and KCN consumption of 0.6-2.59 lbs. and of CaO of 3.4-5.3 lbs. With a 3.0 lb. KCN solution, extractions were 97.4, 95.6, 95.2, 96.5 and 98.7% respectively, KCN consumption 1.05-1.65 lbs. and CaO 3.4-5.4 lbs. These results show precipitation of Au during cyanidation. AHE (1e)

2. ORE REDUCTION

A. H. EMERY, SECTION EDITOR

Development of a Metallurgical Process—Suction Sintering and Roasting (Über die Fortentwicklung eines hüttenmännischen Verfahrens—Saugzug-Sintern und Rösten—). E. J. Kohlmeyer. *Metallwirtschaft,* Vol. 14, Mar. 22, 1935, pages 227-231. The history of the slow development of the process and equipment for its use for various ores is traced. The first commercial application of suction sintering and roasting was for Pb sulphide ores. More recently it has been used for Cu, Zn and Fe ores. The powdered sulphide ores are mixed with other materials to prevent fusing, heated, and air is sucked through the mass. The oxidation then continues by heat of reaction without the need of outside heat. A certain amount of moisture is necessary in the powdered mass to insure the passage of air in the early stages. Later fusion is prevented by the addition of CaO to Pb ores, Fe_2O_3 to Cu and coal to Fe ores. At times the charge is diluted with fully roasted material to reduce the sulphide content. The process is carried out commercially on large conveyor type roasting machines. CEM (2)

2a. Non-Ferrous

Brief Description of the Risdon Works of the Electrolytic Zinc Co. of Australasia, Ltd. *Proceedings Australasian Institute of Mining & Metallurgy,* No. 95, Sept. 30, 1934, pages 247-291. The concentrate contains approximately Zn 52, S 32, Pb 2%, Ag 1½ oz./ton and traces of Cd, Cu and Mn. The ZnS is converted to ZnO in 2 stages. The calcine is leached with spent electrolyte containing 90 g. free H_2SO_4/l. Interfering impurities are removed from the resulting solution. The purified solution is electrolyzed, Zn is deposited and H_2SO_4 regenerated for leaching the calcine. The cathode Zn is removed, melted, and cast into slabs. The leaching and purifying operations consist of the following: (1) Calcine is agitated with spent electrolyte; acid-soluble Zn dissolves; (2) the pulp is classified; (3) the granular residue is ground, floated (to recover unroasted sulphides) and leached; (4) the pulp from (2) and (3) is thickened to remove slime; (5) the slime is filtered, washed, and dried; (6) the solution from (4) and (5) is agitated with ground limestone to neutralize acid and to precipitate Fe, As, Sb and SiO_2; (7) the precipitated pulp is filtered and washed; (8) the filtrate from (7) is treated with Zn dust to precipitate Cu, Cd, Ag, etc.; the pulp is filtered and the precipitate goes to the Cd plant; (9) about 60% of the filtered solution from (8) is treated to recover Co; (10) about 6% of the solution from (8) is treated with Ag_2SO_4 for removal of Cl^-; the AgCl is reconverted to Ag_2SO_4 and reused; (11) the solution is delivered to the electrolytic plant. The slab Zn assays Zn 99.9781-99.98, Pb 0.0150, Cu 0.0009, Cd 0.0050, and Fe 0.0010%. Production of Cd is by a process analogous to that for Zn: (1) oxidation of the precipitate, (2) leaching in Cd circuit spent solution, (3) solution purification, (4) electrolysis and (5) melting and casting. The product assays Cd 99.9738, Zn 0.0120, Pb 0.0120, Cu 0.0020 and Fe 0.0002%. The H_2SO_4 and superphosphate plants are described briefly. AHE (2a)

Comments on the Reducibility of Zinc Ferrites (Note sur la Réductibilité des Ferrites de Zinc). Maurice Ray & G. Baiwir. *Revue Universelle des Mines,* Vol. 11, May 1935, pages 226-228. The mechanism of the reduction of Zn ferrites has been studied to explain some discrepancies in the observations of previous authors. The reduction of a charge of mixed oxides proceeds regularly from the start: the reduction of Fe to the metallic state is much more rapid than the distillation of the Zn. The reduction of a charge rich in ferrites, however, passes through a preliminary period where the Zn is not distilled but where only the Fe oxide is reduced. The ferrite is dissociated and the Zn oxide liberated. The velocity of the Zn distillation instead of diminishing with time as in the case of the oxide charge, increases to the end of the reduction. 5 references. Ha (2a)

Recent progress and the Economic Situation of Nonferrous Metallurgy. Tin. (Les récents progrès et la situation économique des métallurgies autres que la sidérurgie. L'étain). Léon Guillet & Marcel Fourment. *Revue de Métallurgie,* Vol. 32, May 1935, pages 189-199. Sn purification from Fe by means of Fe-Si as used by the Societe d'Electro-chimie et d'Electrometallurgie et des Acieries d'Ugine (French Patent 585,942) is described. Concentrates are mixed with coke, lime and fluxes, briquetted, and melted in an electric furnace to produce monosilicate slag. The slag contains on the average 12% Sn and 25% Fe. Tapped in a ladle the melt separates into liquid Sn and solid slag. The latter is crushed and melted in the same electric furnace with the addition of Fe-Si for a sesqui-silicate slag which is practically free from Sn. The melt cast in a ladle separates into slag, a layer of Fe-Si, which must contain more than 18% Si, and of Sn which is practically Fe free. The latter is purified by liquation. Details of the equipment are given. JDG (2a)

Metallurgy of Nickel (Aperçu sur les Métallurgies du Nickel). Marcel Ballay. *Bulletin de l'Association Technique de Fonderie,* Vol. 9, Apr. 1935, pages 113-121. Paper presented before the Association Technique de Fonderie, Feb. 20, 1935. Most of the Ni used in France is mined in New Caledonia as a complex silicate of Mg, Fe and Ni, containing from 4 to 10% Ni. The reduction of this ore is described in detail. About 90% of the Ni used in the world is produced in Canada. The Creighton mine furnishes an ore containing Ni and Cu in approximately Monel metal proportions. The direct production of Monel metal, refining of Ni by use of Na_2SO_4 or Orford process, and the carbonyl or Mond process are described. 11 references. WHS (2a)

Metallurgy of Non-Ferrous Metals. C. O. Bannister. *Mining Journal, Centenary Number,* 1935, pages 17-18. The main features that have led to present day metallurgical efficiency are reviewed, especially flotation and improvements in smelting methods, exemplified by Cu and Zn. AHE (2a)

Solidification of Metals Containing Gases. C. H. M. Jenkins. *Metal Progress,* Vol. 27, June 1935, pages 62, 64. The pressure casting of Al for reducing the size and amount of gas bubbles is discussed. WLC (2a)

Production of Zinc by Electrolysis (Die Zinkgewinnung durch Elektrolyse). Geo. Eger. *Zeitschrift Verein deutscher Ingenieure,* Vol. 79, May 18, 1935, pages 605-607. A historical description of electrolytic Zn production since its inception in 1916 and statistics of world production are given. Two principal methods are in use, the older one by Siemens-Halske operating witth solutions of $ZnSO_4$ with 10% free acid and current densities of about 500 amp./m.^{2}, and the Tainton process, used particularly in America, operating with about 30% free acid and current densities of 1100 amp./m.^{2} Cathodes of Al and anodes of Pb or Pb alloys are employed, the Zn is deposited as a continuous plate on both sides of the Al cathode. The energy consumption is 3900-4000 kw./ton of Zn at 3.6 volts at the bath, exclusive of current for contingencies such as roasting, leaching, and stirring. The purity is 99.99%, lately even 99.999%. Such Zn is especially soft and can be rolled to extremely thin foils, and is particularly useful for die-casting. 6 references. Ha (2a)

The Nkana Copper Refinery. H. Y. Eagle. *Mining Journal Centenary Number,* 1935, pages 110-111. A brief description. AHE (2a)

2b. Ferrous

New Trends in Iron Production (Neue Wege der Eisengewinnung). *Die Naturwissenschaften,* Vol. 23, Feb. 15, 1935, pages 119-120. In Krupp's "Renn Process," a mixture of about 100 parts of Fe ore containing as low as 25% Fe and 30 parts of cheap fuel (waste coal, coke, etc.) are charged into a rotary drum furnace. The larger Fe lumps are taken out at the end of the kiln and the finer Fe particles are extracted magnetically and returned to the process together with the flue dust. The Fe lumps represent 90-96% of the total Fe in the ore and analyze 97-99% Fe and 0.5-1.5% C. An ordinary ore dressing process yielded only 63.6% of the total Fe present at a cost of 57.50RM/ton as compared with a yield of 94% for the Krupp process and a cost of 38.48 RM/ton. Germany has 5 million tons of suitable low-grade Fe ores. A new trend in Germany is the revival of the small charcoal furnace. EF (2b)

Further Determinations of the External Heat Loss of Blast Furnaces. D. F. Marshall. *Iron & Steel Institute,* May 1935, Advance Copy No. 5, 25 pages. External heat losses from 4 furnaces were determined. During the test periods the production of Fe in these furnaces was from 550 to 2800 tons weekly. A furnace making 2800 tons of Fe/week had a total external heat loss of 6,167,000 B.t.u./hr. Of this loss 83% was through the cooling water, 13.7% from the shaft, 1.5% from the spectacle belt, and 1.8% by conduction through the ground. Results indicated that external heat loss was largely a function of the superficial area of the furnaces and was not materially affected by changes in operation. In all cases the cooling water accounted for at least 83% of the total heat loss. JLG (2b)

Relation Between Open Hearth Slag Charged in a Blast Furnace and the Concentration of P in Pig Iron Produced. Saiti Fukabori. *Tetsu to Hagane,* Vol. XXI, Jan. 25, 1935, pages 1-5. In Japanese. Using data obtained from a blast furnace in which the open hearth slag containing about 10-20% FeO, 50% CaO and 5-15% MnO was charged in various amounts, the relation between the slag charged and the concentration of P in pig Fe produced was considered. When ores containing up to 0.1% P were used the content of P in pig Fe produced did not increase proportionally as the amount of the charged open hearth slag increased up to certain high limit. The economical limit dropped considerably as the content of P in the ores increased over 0.1%. TS (2b)

Present Status of Direct Production of Iron and Steel from Ores. R. S. Dean. *Mining & Metallurgy,* Vol. 16, Apr. 1935, pages 185-186. Direct processes cannot be looked upon as substitutes for any single operation in present Fe and steel practice but must be considered as one link in a new metallurgical process from ore to finished product. Field for direct processes is to be found on ores that are either of high purity or in ores that are not of blast furnace grade in natural state but from which concentrates of high purity can be obtained. Recent studies in field of direct steel have been directed toward methods for rigorous concentration of Fe ores and for reducing these ores directly to wrought Fe or melting base for high quality tool steel. Many ores in this country can be treated to give high recovery and a concentrate analyzing more than 68% Fe. Two newly developed methods for reduction of premium concentrate are: (1) Reduction of hematite ores by natural gas, and (2) Reduction by solid fuels. VSP (2b)

Modern Tendencies in Blast Furnace Practice, Their Influence on Plant and Equipment. L. P. Sidney. *Iron & Steel Industry,* Vol. 8, Feb. 1935, pages 161-168, 202. There is a tendency toward increasing the tonnage of pig Fe produced per furnace, with improvements in the pretreatment of the ores and coke charged; increased attention is being given to methods of charging; reduction is being accelerated by increasing both the temperature and the pressure of the blast. There is steady improvement in blast furnace gas practice. Accurate control and metering are on the increase. CEJ (2b)

Progress in the Sintering and Sinter-Roasting of Ores. H. Wittenberg. *Metallgesellschaft,* No. 10, May 1935, pages 11-16. The modifications recently made in the Dwight-Lloyd blast roasting process and the equipment for treatment of Fe ores are described. The ore is graded into 3 sizes, the finest (0-5 mm.) is sintered before being fed to the blast furnace, the medium sized ore (5-20 mm.) is used as a hearth layer and the coarse ore (20-80 mm.) is fed directly into the blast furnace. A charge of highest permeability is thus obtained. The resulting high fuel content is balanced by adding to the charge admixtures which are poor in or free from fuel. Ha (2b)

3. MELTING, REFINING AND CASTING

The Foundry of 1950. Fred J. Walls. *Iron Age,* Vol. 135, June 13, 1935, pages 19, 78-79. Based on paper read before the sectional meeting of the American Foundrymen's Association at East Lansing, Mich., May 11. Author gives his own conception of the foundry in 1950. Foundries will probably be grouped under: (1) Specialty (one commodity such as piston rings); (2) General jobbing (small quantities); (3) Production jobbing (large quantities); and (4) Corporation foundries (complete lines). Other improvements predicted are: Alloys are to be better understood, cupola will be more efficient, permanent molds will find greater use and directional solidification will be a reality. VSP (3)

Suggests Hangers for Fill-In Work. Fred B. Jacobs. *Foundry,* Vol. 63, May 1935, pages 44, 47. Selecting a fill-in job for gray Fe or non-ferrous foundry, product decided upon should be capable of being produced without making a large investment outlay and product must find a ready market. Suggests self-aligning adjustable shafting hangers. Shows a design for a standard 5/8" shafting. Increasing the proportions hangers can be made in 3/4" or 1" sizes as used for general light manufacturing. Hangers are made from Al bronze, it being lighter than cast Fe. Split patterns are used individually or on a match plate if hangers are made in quantities. VSP (3)

Patternmaking. Alexander Marshall. *Foundry Trade Journal,* Vol. 52, May 23, 1935, pages 343,344,350. Paper read before Scottish Branch of Institute of British Foundrymen. Principles, material, medium-sized patterns, painting of patterns, pattern storage, etc., are discussed by the author. AIK (3)

Method for Judging Molding Sands According to Distribution of Grain Size (Verfahren zur Beurteilung von Formsanden nach der Korngrössenverteilung). Bültmann. *Giesserei,* Vol. 22, June 21, 1935, pages 307-308. A method is developed by which the distribution of grain size in a molding sand is represented in a curve showing the share of a certain grain size as determined by sifting in % of the total amount. This gives a better and clearer insight than tables as sizes between the meshes used are taken care of by the curve. Ha (3)

Ford to Condition Air for Foundry. *Automotive Industries,* Vol. 73, Aug. 17, 1935, page 188. Air conditioning equipment is being installed in various mold rooms of the Ford foundry. It is expected that the temperature and humidity can be greatly reduced and working conditions made more comfortable. Air washing equipment previously used to furnish air to the foundry is reported to have collected about 42 tons of dirt per week. Various inspection rooms, gage rooms, and the cylinder-barrel finishing department are already air conditioned. BWG (3)

Proper Pattern Making Increases the Production (Richtiger Modellbau steigert die Gussproduktion). *Giessereipraxis,* Vol. 56, July 7, 1935, pages 287-290. In discussing the molding method best applied in molding the seat of an inlet valve, paper shows that even a small foundry shop with limited means of production can economically process sound castings. Attaining this end and increasing the production also depends on suitable methods of pattern making. GN (3)

Coal Dust in Molding Sand (Der Kohlenstaub im Formsand). A. Rodehüser. *Giesserei,* Vol. 22, May 24, 1935, pages 244-248. The amount of C dust must be not too low, 6% gave the cleanest casting. More than 12% caused cracks in the surface. The dust should be made of a coal of high gas content, ground as finely as possible and mixed intimately with the sand. Ha (3)

Shrinkage of Castings and its Effects (Die Schrumpfung des Gussstücks und ihre Wirkungen). E. Scheuer. *Metallwirtschaft,* Vol. 14, May 3, 1935, pages 337-344; May 10, 1935, pages 365-367. A thorough description and explanation of shrinkage in castings. It consists of liquid, solidification, and solid shrinkage. The effect of distribution of temperature, shape and design of the mold, mold temperature and casting temperature is discussed. Various types of metals, such as pure metals, eutectics, solid solutions, and primary crystals, due to their difference in solidification range, produce different shrinkage effects. The solubility of gases in metals at various temperatures their effect on shrinkage, deoxidation, and gas distribution are discussed. The formation of shrinkage cracks depends on composition of the alloy, pouring temperature, mold conditions, and other factors. The effect of porosity of various degrees and types on the mechanical properties is described. 20 references. CEM (3)

3a. Non-Ferrous

The Flotation of Non-Metallic Inclusions in Molten Metals. R. Mitsche. *Carnegie Scholarship Memoirs, Iron & Steel Institute,* Vol. 23, 1934, pages 65-105. A large part of this paper is a review of a number of processes referring to the removal of non-gaseous, non-metallic inclusions. The author describes experiments on commercial cast Fe and on Al melts and outlines the preliminary results of his research. The fluorescence microscope was used for the first time for examining non-metallic inclusions in metals and the aluminium-alumina system was investigated. A slag cloud theory was postulated to account for "modification" of silumin. This theory assumes that an increase of non-metallic inclusions reduces the undercooling of the molten metal and thereby produces a tendency toward a coarse acicular eutectic, and conversely, a decrease of non-metallics produces a fine-grained granular eutectic. The theory was confirmed by subsequent experiments. CW (3a)

Melting Conditions of Aluminum. A. I. Krynitsky & C. M. Saeger, Jr. *Foundry,* Vol. 63, Mar. 1935, pages 21-23, 60. See "Effect of Melting Conditions on the Running Quality of Aluminum Cast in Sand Molds," *Metals & Alloys,* Vol. 6, May 1935, page MA 179R/7. VSP (3a)

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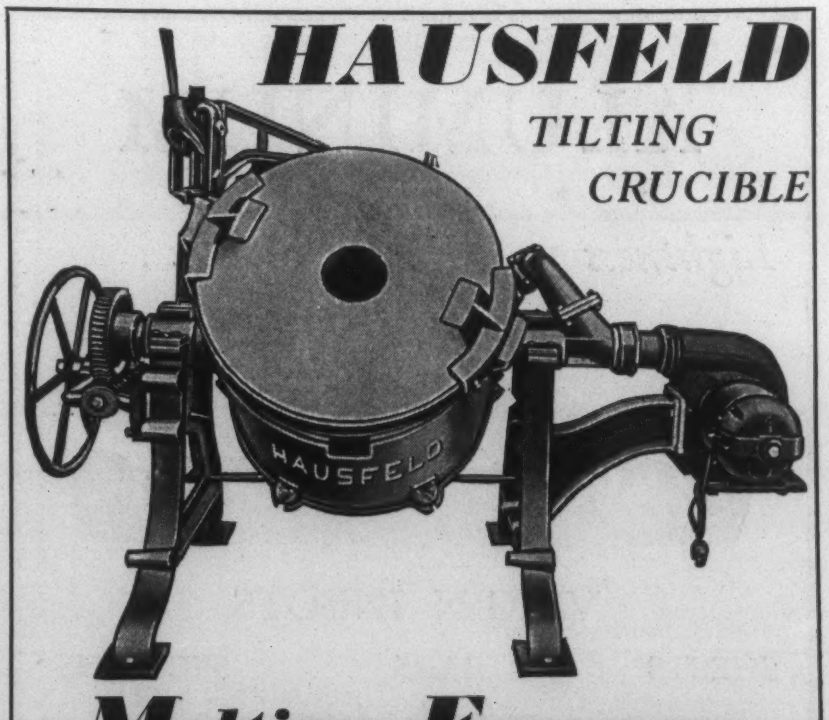

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Production of Zinc-Bearing Machinery Bronze (Zur Herstellung zinkhaltiger Maschinenbronzen) E. R. THEWS. *Die Metallbörse*, Vol. 25, Mar. 9, 1935, pages 305-306; Mar. 16, 1935, pages 337-338. Alloys considered contain 8-12% Sn, 1-3% Zn and small amounts of Pb for hydraulic applications and 3-6% Ni for high pressures. Zn is added primarily to improve the casting properties. The corrosion resistance is improved insofar as additions of Zn furnish denser castings. It also improves elongation and under actual service conditions raises tensile strength because of its densifying action. Typical machinery bronzes show the following physical properties:

	92 Cu 8 Sn	90 Cu 8 Sn 2 Zn	90 Cu 10 Sn	88 Cu 10 Sn 2 Zn	88 Cu 12 Sn
tensile strength in kg./mm.^{2}	21	22	22	23	23
elongation in %	13	14	11	12	9

Al adversely affects the strength of these alloys. It has been reported that the addition of Zn in the form of brass yields better results. The utilization of scrap is critically discussed. The rôle of Ni (1-3%) has not been fully clarified. The author's experience shows that the addition of Ni as a 15 (or 20) % Ni-Cu alloy always yields good results. The author believes that Pb acts in a similar capacity. A maximum limit of 2% should be observed. Pb improves the machining properties. In the presence of Zn, methods to prevent oxidation are generally dispensed with. Additional P promotes brittleness. Recommends deoxidizing with a small amount of P before adding Zn. Cu-phosphide begins to form with 0.05% P. Small additions of Mn improve castability and physical properties. Use of fluxes and suitable casting temperatures is discussed and data on tensile strength in relation to casting temperature are given. EF (3a)

New Investigations on Aluminum Casting Alloys (Neuere Untersuchungen an Aluminiumguss-Legierungen) H. OBERMÜLLER. *Giessereipraxis*, Vol. 56, July 7, 1935, pages 284-285. The paper summarizes the results of investigations on (1) the gas content of these alloys as carried out by Nipper at the Foundry Institute of the Technische Hochschule Aachen, (2) the effect of Cr, Mo, V, etc. on the mechanical properties as investigated by Koch & Röntgen at the same Institute, (3) investigations by Schwarz on the effect of the cross section of the casting on the mechanical properties, (4) investigations by Schwarz & Evers on the temperature effect upon the elastic properties, (5) investigations by Wiest & Dehlinger on aging phenomena, (6) investigations on castability by Zeerleder & Irmann, (7) electric melting of alloys as advanced by Russ. GN (3a)

Problems in Bronze. H. J. ROAST. *Iron & Steel of Canada*, Vol. 17, Nov.-Dec. 1934, pages 84-89. Producing a good bronze from the metallurgical engineering and foundry standpoint is discussed. Correct welding methods, avoiding gas absorption, shrinkage and preparation of control test bars, are described. Ha (3a)

Some Factors which Influence Soundness in Non-Ferrous Castings. ARTHUR LOGAN. *Foundry Trade Journal*, Vol. 52, May 23, 1935, pages 345-348; May 30, 1935, pages 367-368. Paper read before Scottish Branch of Institute of British Foundrymen. Present-day practice, admiralty gunmetal, causes of unsoundness, percentage waste, defects from sand, melting and mold conditions, fluidity, solid cooling, density of castings, etc. are discussed. Before one can say that a particular casting is defective, one should be able first of all to define a perfectly sound casting. There is no such thing, the author states, as a perfect casting. The majority of defects are usually internal and may not be revealed by machining. They may not even be revealed by a pressure test. Fluidity and surface tension effects vary considerably from alloy to alloy. The fluidity and viscosity are dependent to some extent upon the degree of superheat given to the metal. Interesting results were obtained from an experiment in gating and running of 6″ cubes which were cast under various conditions. AIK (3a)

Manufacture of Nichrome. P. V. POPOV. *Vestnik Metallopromishlennosti*, Vol. 15, Jan. 1935, pages 87-103. In Russian. A detailed description of the methods used at one of the Russian plants for making Nichrome. A one ton electric furnace is used. Metal is cast into small chills at about 1480° C. Charge consisted of metallic Ni, metallic Cr, steel scrap and Fe-Mn. Electrolytic Ni cannot be used as it produces a porous alloy which will tear in forging and in drawing. Metallic Cr or a low C Fe-Cr should be used together with low C steel scrap. As a deoxidizer a 50% Ni-Mg alloy added to the ladle is recommended. The quality of the metal produced is sufficiently high, specific resistance being 1.05-1.12 ohm/m./mm.^{2}, which is the same as that of the imported material. (3a)

Die-Casting with Machines of Simple Design. CHAS. O. HERB. *Machinery*, N. Y., Vol. 41, July 1935, pages 669-672; Aug. 1935, pages 721-725. Equipment, materials and methods for die-casting small parts in quantity production are described and illustrated. Ha (3a)

The Kinetics of the Decomposition of Nickel Carbonyl. C. E. H. BAWN. *Transactions Faraday Society*, Vol. 31, Feb. 1935, pages 440-446. Contains bibliography. Using purified $Ni(CO_4)$ experiments were carried out in Ni coated glass vessels at temperatures from 100° to 128° C. The order of the reaction of decomposition was less than one and occurs principally in the gas phase. The reaction is inhibited by CO. PRK (3a)

Pouring White Metal in Bearings and Bushings (Aus der Praxis des Ausgiessens von Lagern und Lagerschalen mit Weissmetallen) *Giessereipraxis*, Vol. 56, July 21, 1935, pages 303-306. The paper stresses a number of points to be observed in casting white metal bearings and bushings, such as proper melting temperature, careful degasification, low casting temperature. The importance of obtaining a fine grained structure and avoiding segregation is stressed and the means to attain this end are dealt with at length. The second part of the paper considers practical devices used in casting. GN (3a)

Present and Future Progress in Bronze Foundry. FRANCIS W. ROWE. *Metal Treatment*, Vol. 1, Spring 1935, pages 12-16. Factors discussed as likely to repay intensive investigation include development of impermeable crucibles, features of different types of melting furnaces, methods of effecting rapid freezing to produce denser castings, avoidance of local unsoundness, and use of synthetically-bonded sands. JCC (3a)

Effect of Casting Temperatures on the Properties of Cast Bronze (Einfluss der Giesstemperatur auf die Eigenschaften des Bronzegusses) *Die Metallbörse*, Vol. 25, Mar. 16, 1935, page 339; Mar. 23, 1935, page 370; Mar. 30, 1935, page 403; Apr. 6, 1935, page 434; Apr. 13, 1935, page 466. High casting temperatures produce coarse grain, porosity due to gas absorption, segregation and sweating out of a Sn-rich segregate. The detrimental effect of too low casting temperatures cannot be overemphasized. It is bad practice to cast a great number of castings from the same crucible in a row. Higher casting temperatures are less harmful in the case of chill castings. P extends the solidification range and Ni restricts it. Data on shrinkage of sand and chill castings of Cu-rich alloys are tabulated and the effect of casting temperatures (1025°-1240°) on 5 physical properties of an 84-16 Cu-Sn alloy are given indicating an optimum pouring temperature of 1140°. Very poor results are obtained even at 1090° C. Literature statements on most suitable casting temperatures vary greatly due to the fact that temperatures have not always been measured during actual pouring. A statistical survey shows that 1120°-1160° represents the most suitable casting temperature. Hardness and density values increase with falling casting temperature. Yield point, tensile strength and elongation can be distinctly improved by annealing treatments. Experiments proved that porous and sound bronze castings contain the same amount of gas. The opinions of various authors on the effect of CO, CO_2, H_2 and N_2 are still controversial. No final conclusions on the cause of porosity are presented. Slightly oxidizing furnace atmospheres and protective glass layers are recommended. EF (3a)

Problem of Porosity in Bronze Alloys (Zur Frage der Porosität der Bronzelegierungen) *Die Metallbörse*, Vol. 24, Nov. 3, 1934, page 1403; Nov. 10, 1934, pages 1434-1435. The porosity of cast bronze is attributed to gas absorption during melting and to the liberation of gases in the mold. The gas content of bronze is traced to (1) absorption from the furnace atmosphere, (2) formation in the melt due to the presence of S, As, C, H, O and oxides, (3) absorption during pouring, (4) presence of H and other gases due to the decomposition of H_2O and other components of the mold in contact with the liquid metal. H does not necessarily cause porosity. The formation heat of ZnO is 141,000 cal. and that of H_2O = 58,000 cal. so that the oxidation of H hardly takes place in bronze melts. The elimination of H by additions of oxides of Pb or Mn is suggested. The author doubts whether CO and CO_2 exert a detrimental effect. Some investigators deny the solubility of CO_2 in bronze and ascribe porosity to CO only. Ni and Fe introduce C which however is transferred into graphite and ascends to the bath surface. The opinions on the effect of SO_2 are still divided. States that the liberation of SO_2 due to decomposition of Cu-sulphide is impossible in bronze. The elimination of larger quantities of S is accomplished by adding soda-charcoal mixtures shortly before pouring. Formerly bronzes were melted in reducing furnace atmospheres to prevent oxidation of the expensive Sn, but in present practice a neutral or slightly oxidizing atmosphere is maintained since CO_2 and SO_2 are less harmful than CO and S. Soda layers are recommended when coke is used as fuel. EF (3a)

Variations of Mechanical Properties of an Al-Mg Alloy as a Function of Refining (Sur les Variations de Propriétés Mécaniques Observées sur un Alliage Aluminium-Magnésium en Fonction de l'Affinage). Henri Fournier. *Comptes Rendus*, Vol. 200, Apr. 15, 1935, pages 1398-1400. Alloy containing 6.4% Mg, 0.38% Mn, 0.34% Si, 0.47% Fe, remainder Al was tested for mechanical properties after treatment in the molten bath as follows: (1) untreated (2) 1% cryolite (3) 0.5% Mo chloride (4) N_2 (5) N_2 then Cl_2 (6) N_2 then Ti chloride (0.10%) vapor (7) Na (0.05%). Best mechanical properties were obtained in sand casting with cryolite additions or Ti chloride. FHC 3a)

The Founding of Manganese-Bronze Propellers. J. E. Newson. *Machinery*, London, Vol. 46, Apr. 25, 1935, pages 107-109. Foundry operations for casting propeller of liner Queen Mary are given with other general details of physical properties of the Mn bronzes. WB (3a)

Makes Bathroom Fixture Castings. J. B. Nealey. *Foundry*, Vol. 63, Mar. 1935, pages 54, 56. Describes the facilities of the Schulte Brass Mfg Co., Cincinnati for making various plumbing fixtures. VSP (3a)

The Practice of Melting Aluminium. A. von Zeerleder. *Foundry Trade Journal*, Vol. 52, Feb. 14, 1935, pages 121-122. Paper was published in *Light Metals Review*, Vol. 1, No. 15. Ready oxidizability of Al, gas absorption, effect of steam in the furnace, etc. are discussed. Due to the ready oxidizability amorphous oxide forms, which possesses practically the same specific gravity as the liquid metal, and remains partially suspended in the melt. These inclusions affect the strength of castings and increase viscosity of the molten metal. The capacity of Al for reducing oxides, such as SiO_2 or iron oxide leads to aluminothermic reduction accompanied by formation of corund. The corund is solid at the ordinary Al melting temperature and forms excessively hard inclusions in the castings. Both gas absorption and oxidation are markedly increased above 800° C. The fluxes used must be dry. Large foundries maintain a drying cabinet at a temperature of 200°-300° C. and make a practice of storing the flux in this for 12-24 hrs. before use. It is a frequent practice after melting to use refining agents in the melt. They frequently contain KCl, NaCl, $CaCO_3$ and NaF, or NaCl, KCl and cryolite in varying amounts. AIK (3a)

A Few Hints for the Aluminum Founder (Einige Ratschläge für den Aluminiumgiesser). H. Nipper. *Giesserei*, Vol. 22, June 7, 1935, pages 287-289. Mistakes often observed in practice are discussed and suggestions to avoid them are made for heating of furnaces, preparing the charge, melting, preparation of molding sand and proper condition of molds. Ha (3a)

Requirements to be Met by Metallic Materials Utilized in Die Casting (Welchen Anforderungen müssen metallische Werkstoffe für die Spritzgusserzeugung genügen?) H. Reininger. *Metallwaren Industrie & Galvano-Technik*, Vol. 33, Feb. 1, 1935, pages 60-61; Feb. 15, 1935, pages 80-81. Melting and casting temperatures, attack of casting machinery, tendency towards changes of chemical composition, solidification range, strength at elevated temperatures, shrinkage and transformations are discussed with reference to the suitability of Fe alloys, brass, Zn, Sn, Pb, Al, Mg, silumin and Al-Zn alloys. EF (3a)

Vacuum Die-Casting Process for Aluminum Bronze. *Machinery*, London, Vol. 46, May 23, 1935, pages 221-224. General text and illustrations of Aurora Metal Co. process. WB (3a)

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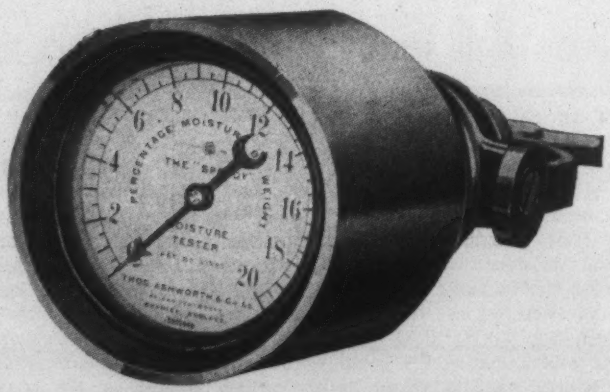

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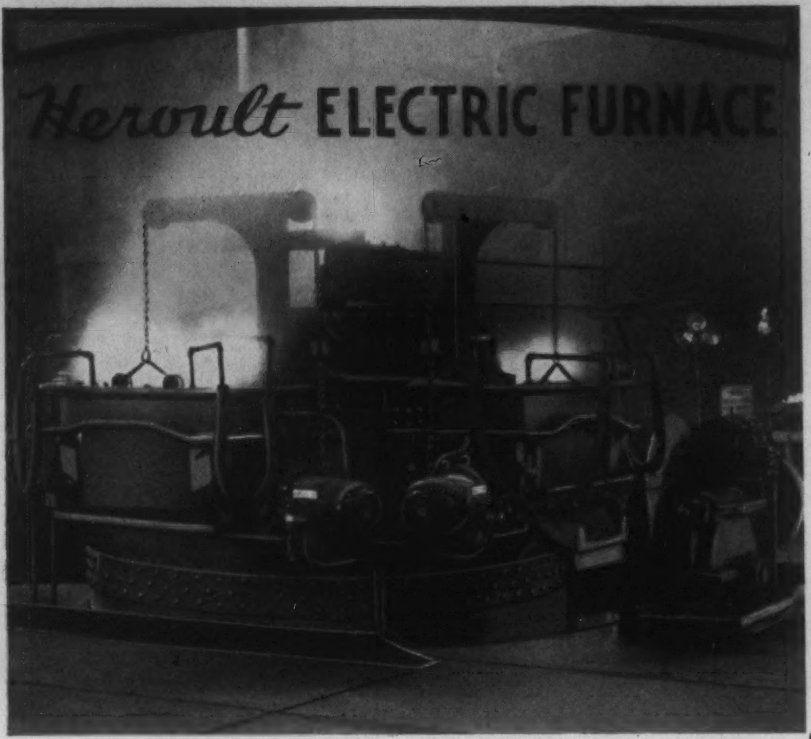

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Studies on Solidification and Contraction in Steel Castings—II. Free and Hindered Contraction of Cast Carbon Steel. CHARLES W. BRIGGS & ROY A. GEZELIUS. *Transactions American Foundrymen's Association,* Vol. 6, June 1935, pages 449-470. Studies are reported on the free and hindered contraction of cast C-steels with varying C contents. The contraction data are obtained on a bar that cools uniformly throughout. The contraction is hindered by means ol springs and the resulting stresses and the amount of contraction correlated. The authors offer the following summary: (1) The total amount of free contraction of cast C-steel decreases as the C content of the steel increases. The contraction varies from 2.47% for 0.08 C-steel to 2.18% for 0.90 C-steel. (2) The amount of contraction of the freely contracting bar taking place prior to reaching the critical range decreases as the carbon content of the steel increases. (3) The amounts of contraction obtained after the freely contracting bars have passed through the critical range are approximately equal. (4) In the case of the freely contracting and the lightly hindered contracting bars, the carbon content influences the rate of contraction markedly until the bars have contracted approximately 0.10%. (5) Hindered bars contract similarly to the freely contracting bars in that, at any temperature prior to the critical range, the amount of contraction is greater with decreasing C contents. (6) The total amounts of hindered contraction increase as the C content increases. (7) The percentage of the total contraction occurring before the critical range is reached decreases as the tension restraining the bar increases. (8) The hindered contraction data obtained with the lightest spring, represent approximately the stresses encountered by the average commercial casting as the total contraction under this tension approximates the "patternmaker's shrinkage" of 3/16"/1 ft. (9) Slight variations from the normal Mn or Si content of cast C-steel do not result in measurable differences in the rate or total amount of free or hindered contraction. (10) The rate of contraction, as well as the strength of the steel, may influence the formation of hot tears in steel castings. (11) The contraction taking place upon the solidification of cast steel as approximated from the available data, is 2.7%. The data are also considered as to practical application and from the specific volume studies, an approximation is made of the solidifying contraction.
CEJ (3b)

Quality of Electric Steel, Arc vs. Induction. HANS DIERGARTEN. *Metal Progress,* Vol. 27, June 1935, pages 61-62. Referring to data presented iu greater detail in *Stahl und Eisen,* 1935, pages 228, 276 it is stated that induction furnace high speed steel shows more uniform distribution of carbides, higher hardness, but no better cutting quality than that produced in the arc furnace.
WLC (3b)

Prevent Losses with Proper Gates and Risers. PAT DWYER. *Foundry,* Vol. 63, Jan. 1935, pages 38, 40, 43; Mar. 1935, pages 44, 47-48; Apr. 1935, pages 42-44, 47. *59th instalment.* Close coöperation is needed between designer and foundryman to offset hazards incident to ill proportioned sections and other factors which interfere with normal contraction and shrinkage of metal. Fillets and rounded corners are advocated on all patterns to prevent formation of incipient cracks. Green sand cores should be used instead of hard, dry ones.

Instalment No. 61. Number of patterns on a plate, their disposition and manner of gating constitute one of the major problems of production. Maximum production calls for as many patterns as can be crowded on plate. Often number must be modified to conform to fluidity range of metal especially in case of pipe fitting subjected to high pressure in service. This involves placing gates in most favorable position for filling mold rapidly and placing of ample feeders at proper points to compensate for shrinkage.

Final instalment No. 62. Deals with the gating methods employed in latest foundry development, the production of malleable Fe pipe fittings in Fe molds.
VSP (3b)

Fluidity Test Equipment for White Iron. ENRIQUE TOUCEDA. *Metals & Alloys,* Vol. 6, May 1935, page 130. Describes pattern equipment and molding technique for testing the fluidity of molten iron. The casting poured is a thin wavy bar and number of waves which run are a measure of the fluidity for the particular conditions of composition and temperature of the test.
WLC (3b)

Make Iron Castings in Steel Shop. WILLIAM F. ROSE. *Foundry,* Vol. 63, May 1935, page 32. Green sand facing and regular steel foundry practice is used in production of gear blanks, die blocks, dampers, pots and other miscellaneous castings. Molds are made according to accepted Fe foundry practice. Principal advantage of using steel foundry facing sand is that it gives a permeability of 325. Resulting casting is true to pattern and presents none of the over weight which follows soft ramming. Large castings up to 5 tons have been made in green sand molds by this method.
VSP (3b)

The Iodine Method for the Determination of Oxides in Steel. T. E. ROONEY & A. G. STAPLETON. *Iron & Steel Institute,* May 1935, Advance Copy No. 7, 6 pages. Apparatus and procedure used at the National Physical Laboratory are described. Main alterations in the apparatus consist in the use of a small Hg safety trap in the N stream, the introduction of a silica-gel tower, and the use of a dry purification train for N instead of alkaline pyrogallol. Results obtained with a "Cella" ultra-filter and with a No. 50 Whatman filter are given.
JLG (3b)

Operations in Making Chilled Car Wheels. ROGERS A. FISKE. *Iron Age,* Vol. 135, Apr. 4, 1935, pages 22-26. Describes the latest practice and equipment in the manufacture of chilled cast Fe car wheels at the reconstructed plant of the Griffin Wheel Co. The cupola is of the Griffin process hot-blast type and can be used either in conjunction with or independently of the air furnace. Both the cupola and air furnace operate on continuous principle. Foundry has a capacity of 1000 wheels in two 8 hr. shifts.
VSP (3b)

Prevent Porosity in Fly Wheel Hubs. J. H. EASTHAM. *Foundry,* Vol. 63, May 1935, page 31. Porosity is caused by faulty design in castings and by careless and inefficient rod feeding after casting is poured. To prevent porosity at a certain plant, a slight chill was applied to bore of wheel. A mild steel plate was fashioned to required dimensions and substituted for the dry sand core. Interior was packed with heap sand. Vent hole was made in center. Edges of plate were left ½ in. apart for contraction of casting. Proper risers were placed on hubs and fed properly.
VSP (3b)

Desulphurization of Steel (Réflexions sur la désulfuration de l'acier). MARCEL GUÉDRAS. *Aciers Spéciaux, Métaux et alliages,* Vol. 9, Nov. 1934, pages 627-628. The classical desulphurization reaction in steel is

$$\mathrm{FeS + CaO + C = CaS + Fe + CO - 32040\ calories}$$

The presence of $\mathrm{CaC_2}$ in electric furnace slag is therefore necessary to insure a complete desulphurization. If this slag also contains more than 1% FeO, desulphurization is incomplete. In slag, most of the constituents tend to decompose FeS dissolved in metal to form CaS, but Fe and especially FeO will decompose CaS and thus give FeS again:

$$\mathrm{Ca + FeS \rightleftarrows CaS + Fe}$$

The FeO and MnO aid this reversibility

$$\mathrm{FeO + CaS \rightleftarrows CaO + FeS}$$

Calcium chloride has been used as desulphurizer, also leucite and feldspar. With potassium salt (leucite) a complete desulphurization can be achieved according to

$$\begin{aligned}\mathrm{FeS + K_2O + C} &= \mathrm{K_2S + CO + Fe + 10460\ calories}\\ \mathrm{FeS + K_2O} &= \mathrm{K_2S + FeO \quad + 47100\ \text{''}}\end{aligned}$$

Leucite contains 55% $\mathrm{SiO_2}$, 22% $\mathrm{K_2O}$, 23% $\mathrm{Al_2O_3}$, Feldspar (ortho) having a chemical composition 6 $\mathrm{SiO_2}$, $\mathrm{Al_2O_3}$, $\mathrm{K_2O}$ is also effective as desulphurizer.
GTM (3b)

Making Quality Steels. EMIL GATHMANN. *Blast Furnace & Steel Plant,* Vol. 23, May 1935, page 333. Discusses successful production of rimmed ingots in big-end-up molds. In top casting, mold height should be limited irrespective of cross-section, and should not exceed 70 in. for average size ingot. There should be a straight section in upper portion of mold for 10-20% of its volume. Bottom should be necked in. Bottom crop from blooms rolled from big-end-up ingots of correct design need not exceed 1% of ingot volume. Wider range of steels can be rimmed in big-end-up molds.
MS (3b)

Finishing the Heat of Steel. Pt. XXXII. J. H. HRUSKA. *Blast Furnace & Steel Plant,* Vol. 23, May 1935, pages 322-324. Deals with pipe curves in ingots. Theoretically, according to several investigators, ingots without any taper of either cylindrical or any other symmetrical cross-section should have a pipe curved assymptotically to vertical axis. Actually transverse shrinkage and imperfect flow of liquid steel counteract formation of pipe extending to near the bottom. Nevertheless, pipes are found extending to point of base pyramid in ingots without taper. Big-end-down ingots should form primary pipe deep into ingot body with a secondary shrinkage cavity in lower portion. Actually, this is found only in very long, narrow ingots. Theoretical and actual curvatures of pipes in inverted ingots are fairly identical. This is true also of shrinkage cavities in sink-heads and hot tops, indicating same thermal function of hot tops and positive taper.
MS (3b)

Residual Metals in Open-Hearth Steel. John D. Sullivan. *Metals & Alloys,* Vol. 6, May 1935, pages 134-137. Brings the records of residual metals in open-hearth steel of 18 different plants up to date with years 1931-35 inclusive, shown. Analytical methods employed are given in detail. Elements studied are Ni, Cu, Sn, Mn and Cr. WLC (3b)

Steel is Desulphurized by Addition of Beryllium. W. Kroll. *Steel,* Vol. 96, May 27, 1935, pages 62-63, 68. Translated by Richard Rimbach from *Metallwirtschaft.* See "Desulphurizing Iron with Beryllium," *Metals & Alloys,* Vol. 5, July 1934, page MA 320. MS (3b)

Determines Iron Lost in Melting. William McConnachie. *Foundry,* Vol. 63, Apr. 1935, pages 26, 56. Gives method of calculating Fe loss from analysis of gas produced in the cupola. Includes results of other investigators on calculating Fe loss from ordinary type of cupola and Poumay type. VSP (3b)

The Determination of FeO and MnO in Steel with Mercuric Chloride (Ueber die Eisen- und Manganoxydul-Bestimmung im Stahl mit Quecksilberchlorid). E. Maurer, P. Klinger & H. Fucke. *Archiv für das Eisenhüttenwesen,* Vol. 8, Mar. 1935, pages 391-398. An analytic method, in which the steel is dissolved in an aqueous solution of $HgCl_2$ and the FeO and MnO remaining behind determined, is described and its utility tested. The stability of FeO and MnO in the $HgCl_2$ solution is substantiated; the effect of the presence of compounds of Fe with C, Si, P, S, and N as well as of MnS is discussed. Various steels were analyzed for FeO and MnO by this method and the results compared with those by other methods; in some samples fair agreement was obtained, in others not. The method appears to be applicable to steels low in P, S, and N ($< 0.05\%$) and Cr $< 0.40\%$. SE (3b)

Pipe Cast Centrifugally Without Chill. J. B. Nealey. *Iron Age,* Vol. 135, May 23, 1935, pages 14-18, 94, 96. Describes the de Lavaud centrifugal process of making cast Fe pipe using a water-cooled rotating steel mold into which molten Fe is charged from specially designed trough. A thin layer of ferro-alloy powder is blown against inside walls of mold in advance of stream of Fe as it is being poured. The powder prevents chilling. Annealing period is about 1 hr. Pipe made by this process has 100% more impact resistance, greater ductility and toughness, and is easier to cut and tap. Long pipes are made on turntable pit. Gives information on gas furnaces used. VSP (3b)

Newest Plant for Centrifugal Casting of 30 Inch Pipe. J. B. Nealey. *Industrial Heating,* Vol. 2, May 1935, pages 247-250, 263-264. The process of casting pipes centrifugally in green sand molds and the machinery used are described in detail. Ha (3b)

Ingot Moulds, Bottoms and Slag Ladles. J. Blakiston. *Foundry Trade Journal,* Vol. 52, Feb. 28, 1935, pages 153-154; Mar. 7, 1935, pages 175-176. This paper was read before the Middlesbrough branch of the Institute of British Foundrymen. The author gives a brief description of the lay-out of a foundry suitable for the production of 400 tons per week of ingot molds, stools and slag ladles. There are 2 principal types of molds—closed bottom and the open type. The design has a very great influence on the performance of molds. In one instance it was found that removal of only ¼″ of metal from the thickness at the bottom of the mold increased the average life of a 7 ton mold by 10%. A thin mold will resist cracking much better than a thick one. The best average life was given by metal containing 1.8% Si and 1.2% Mn. One can therefore assume that the most suitable analysis for ingot molds is the following:—

Total C = 3.50 minimum; Comb. C = 0.50 maximum; Si = 1.80;
Mn = 1.20 maximum; S = 0.03 maximum and P = 0.06% maximum.

The author refers to some 4 ton molds made in Austria, containing 4.5% of total carbon. These molds were made from charcoal iron, and were naturally very expensive but the lives reported were from 350 to 400 castings which are truly remarkable results. AIK (3b)

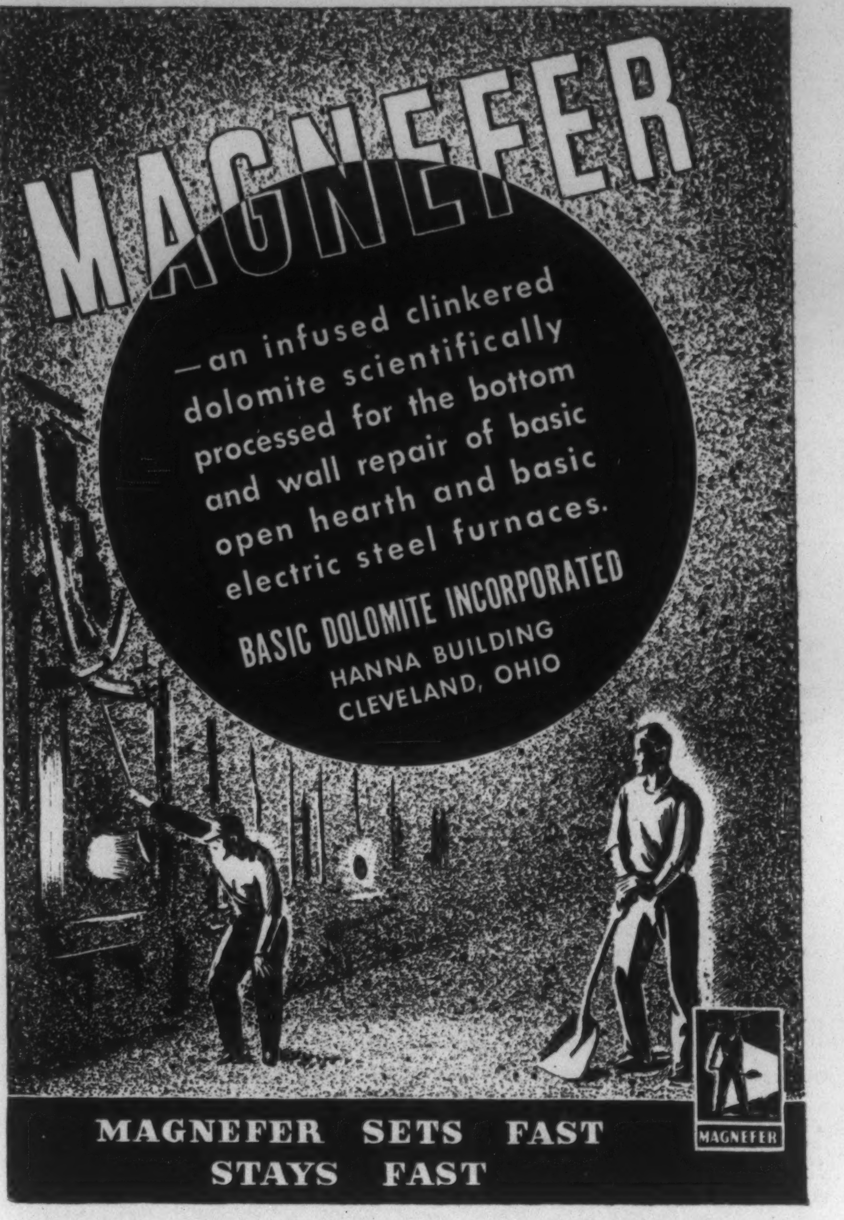
Simplify Molding of Steam Chest. H. W. Kelly. *Foundry,* Vol. 63, Mar. 1935, pages 30-31, 68. Describes the molding of a steam chest on a jolt rollover machine. Costs were reduced by installation of new molding machine, special pattern and steel flask. Typical analysis of the metal used is: Si 1.15 to 1.20%; P 0.20% or under; Mn 0.70 to 0.80%; S under 0.10%. It is close grained, will stand high steam pressure and has long wearing qualities. VSP (3b)

Effect of Deoxidation on the Impact Strength of Carbon Steels at Low Temperatures. C. H. Herty Jr. & D. L. McBride. *Carnegie Institute of Technology & Mining & Metallurgical Advisory Boards, Cooperative Bulletin* No. 67, 1934, 52 pages. See extended abstract, *Metals & Alloys,* Vol. 6, Mar. 1935, pages 71-77. AHE (3b)

The Ternary System FeO-CaO-SiO$_2$ (Le Systeme ternaire FeO-CaO-SiO$_2$). M. Moray. *Revue Universelle des Mines,* Vol. 11, Mar. 1935, pages 141-152. The various methods for determining the fusibility of slags are critically reviewed and the equilibrium diagram FeO-CaO-SiO$_2$ is established. Three distinct phases exist: one which does not dissociate before melting, one which decomposes before melting, and one in which the liquids are in equilibrium with a crystalline phase formed by mixed crystals. The influence of other elements is discussed and composition of several slags described. 33 references. Ha (3b)

Modernistic Trends. J. R. Miller. *Blast Furnace & Steel Plant,* Vol. 23, Apr. 1935, page 269. Criticizes present steel-making processes. Most of the steel made has been of inferior or indifferent quality. When a suitable method of reducing Fe from ore that has been carefully purified will have been developed, steel can be compounded by simple methods from the pure metal, rather than extracted from a mass of undesirable substances. MS (3b)

Improvement of the Quality of Cast Iron in Cupola Furnaces (Elaboration des Fontes de Qualité aux Cubilots). A. Poumay. *Revue de Fonderie Moderne,* Vol. 29, Feb. 25, 1935, pages 52-56; Mar. 10, 1935, pages 81-83. The present methods which tend to produce a high quality cast iron, and the work on them by Maurer, Moldenke, Osann and others are reviewed. The importance of C, Si, Mn, P and S and their reactions are described and practical hints given for determining the best amount and most suitable melting processes. Ha (3b)



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Making Quality Steels. Emil Gathmann. *Blast Furnace & Steel Plant,* Vol. 23, Mar. 1935, pages 201, 203. To obtain uniformly good mold life, all units of a heat should be stripped as soon as possible; molds should be spaced on the cars at least 1/8, and preferably 1/6, the bottom diam. of the molds; and they should be transposed on the cars after each heat. MS (3b)

The Technique of Chilling. J. Roxburgh. *Foundry Trade Journal,* Vol. 52, Apr. 11, 1935, pages 249-251. Paper read before the Sheffield branch of the Institute of British Foundrymen. The author emphasizes certain essential principles of chilling and densening and indicates the degree of control necessary for success. Chill depths for various uses, densening, Cr chill, effect of thermal history, effect of elements on chill, making chilled test-piece, Mn-S ratio, casting temperature, etc., are discussed. Composition, the author states, is not everything, but is merely a guide, and it is the ultimate structure obtained which is the important point. Chill tests are particularly useful where the machining qualities of casting are of vital importance. For instance, Fe containing total C 3.2, Si 1.2 and Cr 0.7%, showing 1⅜″ depth of chill on a test piece, would permit machining a casting 1″ thick, cast in a dry sand mold. Any lowering of the total C content, reduction of the Si or increase of Cr would render the Fe unmachinable. The test-piece measures 6″ x 6″ x 1⅛″ usually made in a core, and placed on an iron slab 8″ x 5″ x 2″ thick. This slab is heated, coated with blacking, and then the metal is poured and allowed to remain for 5 min. A test piece is then cooled in air and finally quenched in cold water. AIK (3b)

New Electric Steel Plant at Rehon (La nouvelle aciérie électrique de Rehon). R. Sevin. *Journal du Four Electrique,* Vol. 44, May 1935, pages 173-175. Mechanical features of a 20-ton electric arc furnace of Heroult type installed in 1934. JDG (3b)

Modern Trend of Steel Melting Practice. T. M. Service. *Iron & Steel Industry,* Vol. 8, Feb. 1935, pages 179-182, 212. Modern tendency in steel making practice is in the direction of increasing the capacity of the furnaces. A capacity of 60 tons per charge for open-hearth furnaces seems most economical. In the open-hearth furnace, the outstanding development is probably shown in design, material and general build of parts. The melting capacity of the high frequency furnace is gradually being increased. Future electric furnaces for steel melting and refining, designed to operate either as high- or low-frequency units, will be flexible as regards movement of the charge and economical in operation. CEJ (3b)

The Steel Foundry. C. W. D. Townsend. *Iron & Steel Industry,* Vol. 8, Feb. 1935, pages 175-178. A general discussion pointing out the difficulties with which the modern steel founder has to contend. Improved design, plant and equipment have combined to make the steel casting of today reliable. CEJ (3b)

Melting of Ferrous Metal in the Electric Furnace (La Fusion des Métaux Ferreux au Four Electrique). M. Wettstein. *Electricité (Science et Industrie),* Vol. 17, Apr. 1935, pages 151-154. General article on application of arc furnace in steel melting. FR (3b)

4. WORKING

Billet Chipper Motorized. *Electrical World,* Vol. 105, June 22, 1935, page 31. Machine supersedes tedious flaw-removal methods. Speed and manipulability are featured. CBJ (4)

4a. Rolling

RICHARD RIMBACH, SECTION EDITOR

Electrical Aids to Precision Rolling of Steel. Pt. 1. Selsyns—Electric Gages—Draft Gages. HARRY A. WINNE. *Iron Age,* Vol. 135, Mar. 28, 1935, pages 18-21; **Pt. 2. Electron Tube Devices.** Apr. 11, 1935, pages 12-15, 66. Includes bibliography. Part 1 describes the use of Selsyn units in connection with mill screwdowns, in warp counter on reel of cold strip mill and in length measuring device applied to hot sheet mill. Electric gages are applied to continuous gaging of cold rolled strip. Cold rolling mill draft gage uses a small generator on entering and delivery guide rollers. Part 2 describes electron tube devices, used to maintain constant tension in reeling wire, control lighting, in flag or limit switches on rod mill shears, plate mill tables, automatic sheet catchers, etc. Also includes brief description of pliotron and thyratron tubes, and the phototube or "electric eye." VSP (4a)

Rolling of Metals with Special Reference to the Sheet and Tinplate Industry. J. SELWYN CASWELL. *Sheet Metal Industries,* Vol. 9, Feb. 1935, pages 75-76. A general discussion of the deformation of steel between rolls. AWM (4a)

Development in Manufacture of Seamless Tubes. GILBERT EVANS. *Metallurgia,* Vol. 12, May 1935, pages 27-28, 34. Describes Foren process for rolling tubes. In this process a tube is hot rolled through several stands and over a hardened steel mandrel. Mention is made of the Diescher mill. JLG (4a)

Design of Electric Drives. PHILIP M. GALLO. *Blast Furnace & Steel Plant,* Vol. 23, Mar. 1935, pages 185-187; Apr. 1935, pages 262-265; May 1935, pages 326-328, 342-343. Presents equations to facilitate calculation of characteristics of drives for heavy-duty service, such as rolling-mill tables. MS (4a)

Direct Rolling: an Actuality with Metals—A Possibility with Steel. T. W. LIPPERT. *Iron Age,* Vol. 135, Mar. 21, 1935, pages 10-17. Describes the process of direct rolling of metals and steels. Includes a sketch of a continuous unit for direct rolling of a strip of metal, if all the conditions are favorable. When all variables, such as static pressure, temperature of metal and the rolls, speed and separation of roll, have been carefully controlled, the strip can be further reduced by hot rolling after which usual physical properties can be secured by cold working. The direct method is successful with brass (m. p. at 940° C.) and with Cu (m. p. at 1083° C.). Experiments are being conducted for rolling metals up to 1500° C. Some degree of success has been attained with plain and complex steels (m. p. from 1400°-1500° C.). Gives method of direct rolling of brass and tabulates physical properties obtained. Advantages of this method of rolling are: (1) Saving of labor and other expenses involved in rolling and annealing; (2) Ductility and soundness of the metal; and (3) Lends itself admirably to large unit operation. Successful rolling of brass has opened the way to direct rolling of other metals and ultimately the probable commercial rolling of steel. VSP (4a)

Rolling of Larsen's Piling in Domestic Plants. B. S. SHAPIRO. *Domez,* No. 2, 1935, pages 40-41. In Russian. A new and convenient scheme is proposed for forming the socket for the interlock directly in the rolls. (4a)

Wide Strip Mills. J. H. VAN CAMPEN. *Iron & Steel Engineer,* Vol. 12, June 1935, pages 367-369. Descriptive of present designs and problems before the producers of strip mills in direction of mill capable of producing much wide strip for automotive body work. WLC (4a)

Influence of Design on the Effective and/or Economical Operation of Rolling Mills. T. W. HAND. *Journal West of Scotland Iron & Steel Institute,* Vol. 42, 1934-35, Part 3, pages 37-44. A review of developments in the design of rolling mills and auxiliary equipment. Electric driving shafts and couplings, bearings and lubrication and facilities for roll changing are discussed. The layout of the continuous mill of the Whitehead Iron & Steel Co., Ltd., and of the mill of Colville, Ltd., are shown. GTM (4a)

Defects in Strip from Continuous Mills. T. N. KEELAN. *Blast Furnace & Steel Plant,* Vol. 23, July 1935, pages 461-463, 468. Discusses metallurgical problems encountered. Investigation of customer complaints relative to breakage during forming disclosed that this was caused by age hardening, dirty steel and failure of processing set-up and lay-out of mill to develop maximum ductility. Surface imperfections after forming were of various types. Short jagged type of slivers was due to scale which adhered to soft rolls in hot mill and became embedded in hot mill coil. Lenticular shaped type of slivers was due to surface condition produced on slabs in heating furnaces under certain conditions of combustion and flame. Skin or surface pipe and mottled surface were caused by dirty steel. Stretcher strains were eliminated by proper reduction in pinch passing, skin rolling, or sheet rolling. Difficulties in meeting the required physical properties at the mill were caused by incorrect finishing and rolling temperatures; excessive reductions in cold mill; faulty annealing, normalizing, sheet rolling, and skin rolling practice; dirty steel; and hard steel due to presence of alloys. Surface defects at the mill were cracks and rough edges, eliminated by controlling amount of pig-Fe in open-hearth charge; seams, slivers, surface pipe, etc., due to dirty steel; rolled-in scale; scale formed on cold rolled material by excessive normalized temperatures, and ineffective dulling or etching, and surface discolorations occurring in pickling. MS (4a)

4b. Forging & Extruding

A. W. DEMMLER, SECTION EDITOR

Lead Extrusion. *Electrical Review,* Vol. 117, July 26, 1935, page 118. W. T. Henley's Telegraph Works, Ltd., has developed a Pb-extrusion machine for the production of continuous cable sheathing. Molten Pb passes into a space between a rotating driver and a fixed threaded point holder where it is cooled externally. Rotating driver takes hold of semi-solid Pb and forces it forward into the die chamber and out between the die and point as a solid tube. Pipe is always uniform and is claimed to have no imperfections. MS (4b)

Forging in the Far East. G. W. MOTHERWELL. *Heat Treating & Forging,* Vol. 21, June 1935, pages 271-274. Relates author's experiences in starting forge shop at Datsun plant of Nissan Automobile Company, Yokohama, Japan, and describes visit to a "home industry" shop. MS (4b)

Making Large Forgings. M. A. GONCHAROV. *Vestnik Metallopromishlennosti,* Vol. 15, Jan. 1935, pages 104-125. In Russian. A detailed description of consecutive steps involved in the manufacture of large forgings. (4b)

4c. Cold Working, including Shearing, Punching, Drawing & Stamping

Cold Finished Bars, Properties and Applications. J. D. ARMOUR. *Metal Progress,* Vol. 27, May 1935, pages 43-48. Describes briefly the processing equipment used in cold finishing steel bars. Qualities of steel for special purposes such as machine parts, carburizing, and cold heading are discussed. Many special shapes now available in this type of finish result in substantial economies in material and machining expense. WLC (4c)

The Production of Turret Top Bodies at Pontiac. JOSEPH GESCHELIN. *Automotive Industries,* Vol. 72, Mar. 16, 1935, pages 386-389. Features in the production of seamless steel automobile tops and body parts are described. Body sheets are first blanked then go through stretcher-leveler machines before entering the battery of 4 huge top presses. Formed corners at the window openings in panels and doors are annealed with oxy-acetylene torches to eliminate strain at these points. Tools used in heavy duty welding are water cooled. Gas welds at the junction of the turret top and side panels are soldered to give smoothness. BWG (4c)

Effect of Recovery from Cold Working on Recrystallization (Einfluss der Erholung auf den Rekristallisationsprozess). M. KORNFELD & W. PAWLOW. *Physikalische Zeitschrift der Sowjetunion,* Vol. 6, No. 6, 1934, pages 537-558. Al wire of 99.5% Al was cold worked by stretching it 4%, heated for 20 hours at temperatures varying between 100° and 450°C. (and 1-20 hours at a constant temperature of 320°C.) and then fully recrystallized at 450°C. The effect of the crystal recovery from cold deformation on the number of crystals in the recrystallized metal has been quantitatively investigated. The same type of curve representing the above interrelations was also found with the changes of yield point due to crystal recovery at 100°-400°C. The number of crystals forming during recrystallization at 450° and 500°C. in relationship to the amount of cold work was also studied. A quantitative investigation of the linear crystal growth and the lengths of the incubation periods for the formation of crystal nuclei during recrystallization at 450°C. in the cold worked and recovered state showed that the mean crystal growth does not vary due to recovery whereas the mean incubation time increased 6.6 times. It is concluded that changes of the grain size must be ascribed to the changes of the incubation period. A hypothesis on the nature of the latter phenomenon is set forth. EF (4c)

4d. Machining

H. W. GRAHAM, SECTION EDITOR

Ford Adopts Single Point Boring. J. GESCHELIN. *Automotive Industries,* Vol. 73, July 27, 1935, pages 110-112. Perfect cylinder bores are the result of the development and use of a battery of 8 eight-spindle, high-speed precision boring machines using single point cutting tools tipped with a suitable grade of cemented carbide. Standard atmospheric conditions are maintained while boring and honing by means of air conditioning. The boring tools are good for at least 500 bores per grind operating at a speed of 520 r.p.m. and feed of 0.007 in. per revolution of the spindle. Each machine has an output of 28 blocks per hour. Single honing only is used, with only 6 passes of the hone necessary. BWG (4d)

Machining of Light Metals (Bearbeitung von Leichtmetallen mit spanabhebenden Werkzeugen). W. WEGENER. *Metallwaren-Industrie & Galvano-Technik, Section Werkstoffkunde & Verarbeitungstechnik,* Vol. 33, Feb. 15, 1935, pages 81-83; Mar. 1, 1935, page 103. Furnishes practical instructions on (1) turning, (2) milling, (3) drilling, (4) reaming, (5) thread cutting, (6) sawing, and (7) filing of light metal alloys. The utilization of special tools is urged since it entails savings up to 70%. Whereas detailed data on cutting speed, shape of tool, cutting angle, feed, etc., are furnished, only the trade names and no analyses on the (German) light metal alloys tested are given. EF (4d)

5. HEAT TREATMENT

O. E. HARDER, SECTION EDITOR

Causes of a Decarbonized Outer Skin. E. F. Lake. *Heat Treating & Forging,* Vol. 21, June 1935, pages 283-284. Specimens of tool-steel were heated to various temperatures in atmospheres of air, CO_2, O_2, H_2, steam, CO, and CO with Fe_3O_4 in furnace. Results indicate that the higher the temperature to which steel is heated above the upper critical in certain atmospheres, the greater the depth of decarburization. Oxidizing gases or a good oxidizing agent dissolved in a molten—for example, PbO in Pb bath—cause removal of C by oxidation at the surface. No decarburization took place in H_2 and pure CO atmospheres. Depth of decarburization increased in a constant ratio with repeated annealings. It is evident that cutting-tool steels should not be annealed any more times than necessary to relieve internal strains and that annealing or hardening heats should never be carried more than 10° above the upper critical point and that steel should not be held at this temperature for more than 10 min. for average size tools. MS (5)

Steel and Its Heat Treatment. D. K. Bullens. John Wiley & Sons, New York, 1935. Cloth, 6 x 9 inches, 580 pages. Price $5.00.

This is merely a reprinting of the third edition of Bullens' standard work, which appeared in 1927, plus a 16 page chapter on nitriding written by V. C. Homerberg. The preface to this printing states that nitriding has been the outstanding development in heat-treating from the practical viewpoint in the period 1927-1935, hence the addition. It would have seemed more accurate to the reviewer had the preface stated that important advances had been made in this interim along so many fronts that to make the book up-to-date would have required so extensive a re-writing as to be too tough a job, and, believing that his discussion of fundamentals still remained sound and valuable (as it does remain), he let it go as it was. Without reflection upon the good, concise, chapter on nitriding, it would seem that grain size control in its relation to heat-treatment, controlled atmosphere heat-treatment, Mo Tung and many other molybdenum steels, precipitation-hardened copper steels, and a dozen other topics that are new since 1927, at least from the commercial point of view, merit equal attention. One can sympathize with the difficulties of an author faced with the task of boiling down all the new knowledge and modern practice in his field into small compass, but the Rip Van Winkle attitude of the preface deserves less sympathy. H. W. Gillet (5)—B—

Cost of Heat-Treating Bolts Cut by Efficient Cleaning. Charles D. Overly. *Iron Age,* Vol. 135, June 13, 1935, pages 20-21, 88. Describes method used at plant of the Oliver Iron & Steel Corpn. in the manufacture of bolts and screws. S-base oil used as lubricant for bolt thread cutting dies damages electric furnace on heat treating and also causes discoloration and apparent oxidation of product. Installation of bolt washing equipment prolonged the life of heating elements in furnace and reduced heat treating costs. VSP (5)

Some Aspects of Heat-Treatment. J. H. Andrew. *Metal Treatment,* Vol. 1, Spring 1935, pages 11-12. Automatic devices do not eliminate the need for technical control. Steel must have the proper structure before heat treatment. To prevent surface decarburization, Andrew recommends, when final treatment is below 1000°C. that this be preceded by a very high temperature anneal. This produces an overheated structure but also forms a semi-liquid scale which retards further oxidation and enables rapid diffusion of C to compensate for any decarburization. The final treatment refines the large grain size so produced. JCC (5)

Heat-Treating a Thousand Different Parts. J. B. Nealey. *Industrial Heating,* Vol. 2, July 1935, pages 345-348. Materials, equipment and methods used for heat-treating small parts of Be-Cu, steels and alloys are described. Ha (5)

5a. Annealing

Processes for Bright Annealing of Metals (Les Procédés de Recuit clair des Métaux). L. Grangette. *Usine,* Vol. 44, July 11, 1935, page 30. Different processes of bright annealing with and without protective gases, and equipment used are briefly discussed. Ha (5a)

A New Method of Heat-Treating Rails. John Brunner. *Iron Age,* Vol. 136, July 11, 1935, pages 20-24. Describes a special normalizing process developed by the Illinois Steel Co. for use in production of rails giving a product of greater ductility and resistance to impact, and with greater resistance to wear and to end batter. See *Metals & Alloys,* Vol. 6, May 1935, page MA 185L/1. VSP (5a)

5b. Hardening, Quenching & Drawing

Quenching and Structure of Ball Bearing Steel. A. Mitrofanov. *Vestnik Metallopromishlennosti,* Vol. 15, Feb. 1935, pages 79-86. In Russian. A study of quenching conditions leading to optimum results with 1.11 C, 0.3 Mn, 0.25 Si, 0.94 Cr steel. The best results as to hardness and toughness were obtained by quenching from 820-840° C. in sunflower seed oil kept at 150° C. (5b)

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Hardening Tool Steels in Controlled Atmospheres. S. K. OLIVER. *Steel,* Vol. 96, June 24, 1935, pages 30-32, 48. Paper read before tri-chapter meeting of the Dayton, Columbus, and Cincinnati chapters of the American Society for Metals, Apr. 15, 1935. Gives results of plant investigation. Atmospheres used by Sam Tour in New York and by several Cleveland plants for hardening high-speed steel were found to be unsatisfactory in Dayton. O reported a preheat atmosphere containing 2.5% CO_2 and 12.5% CO and hardening atmosphere of 3.4% CO_2 and 9.2% CO gave best results. In hardening H_2O and oil hardening steels containing 0.70-1.30% C in box-type electric furnace, best results were obtained with an atmosphere of 4% CO_2 and 6% O_2. In box-type gas furnace, best results were observed with an atmosphere of 5% CO_2 and 4.4% O_2. Only objectionable feature in both cases is a slight scaling. No atmosphere was found which would harden these steels without scale or decarburization in retort type of equipment, with atmosphere supplied by reforming air and gas in a separate unit. High-C, high-Cr steel can be hardened without scale and decarburization in box-type electric furnace, using atmosphere of 2.5% CO_2 and 12.5% CO and in retort-type furnace, using raw gas which cracks down to 12% CO. These methods are far better than the pack method. Presence of traces of CO_2 in atmospheres produced by cracking blended oil causes decarburization. Proposes furnace design and atmospheres which, it is claimed, will harden without scale or decarburization and in any locality all classes of tool-steels from SAE 1020 to the complex Mo-W high-speed steels. It is a semi-continuous, muffle furnace divided into 3 temperature zones, from preheating to hardening. Required composition of atmosphere in each zone is maintained by introduction of air and gas in proper ratios at cold end of muffle. MS (5b)

Die Failures, Their Diagnosis and Cure. LUTHER H. WILLIAMSON. *Metal Progress,* Vol. 28, June 1935, pages 32-37. Discusses such causes of tool failure as improper heating, poorly selected temperature for the tool and composition of steel, imperfect removal of strains in drawing and grinding cracks. Mention is made of failures due to improper alignment or support in presses of the working dies. A device for partial hardening is described for avoiding excessive thermal stresses by heating entire tool above Ac_3 and cooling the parts desired soft by application of wet pads replacing in a furnace and equalizing temperature suitably above Ar_3 and quenching. Thus the parts desired soft have a very high draw and parts desired hard are hardened by the final quench. WLC (5b)

Hard-Facing Valve Seats at White Motor Plant. F. B. JACOBS. *Modern Machine Shop,* Vol. 8, July 1935, pages 28-32. The method to provide a hard facing of stellite on a steel valve seat is described. Ha (5b)

Surface Hardening of Steel by Quenching (Oppervlakkig harden van staal door afschrikken). *Polytechnisch Weekblad,* Vol. 29, Jan. 24, 1935, page 53. Summarizes experimental work by Haller & Zorn on surface hardening of steel by raising the temperature above the Ac_3 point, followed by quenching (water, compressed air). A neutral oxygen-acetylene torch is utilized, which, at a rate of 120-200 mm./min., furnishes heat at a faster rate than heat conduction into the interior regions of the work. Steels with 0.4-0.6% C and 1.2% Mn max. are utilized. 2-5% Ni exert no influence on the hardening qualities and steels with a maximum content of 1% Cr are suitable. Pearlitic cast Fe can also be hardened. According to a diagram included, the surface hardness of an 0.3% and 0.7% C steel can be raised from 110 to 530 Brinell and from 190 to 700 Brinell respectively. An apparatus designed for hardening the surface of gears is illustrated. WH (5b)

5c. Aging

Tempering Copper. G. W. PRESTON. *Electrical Review,* Vol. 116, June 28, 1935, page 940. Discusses merits of precipitation hardening. Addition of other elements to Cu for purpose of improving mechanical properties reduces conductivity considerably, but much less so if hardening constituent can be precipitated. Development of such alloys makes available materials with enhanced strength having electrical and thermal properties greater than those hitherto obtainable in materials with similar mechanical properties. Promising metals for this purpose are Be, Cr, Co, Ti, and combinations of Ni with Al, Si, or Sn. For example, alloy containing 2.5% Be has an electrical conductivity in untempered condition of about 17% of that of pure Cu, and thermal conductivity of about 30%, with a tensile strength of 33.6 tons/in.^{2} and Brinell hardness of 98. In tempered condition, electrical and thermal conductivities are 32% and 42% respectively; tensile strength is over 89.6 tons/in.^{2}; Brinell hardness is about 400; load required to produce permanent extension of 0.003% may be increased to 32.5 tons/in.^{2}; with elongation reduced to 1%; and resistance to fatigue failure is unusually good. Because of cost, applications are limited to small parts where great strength or hardness is required. MS (5c)

5e. Carburizing

Carburizing with Gas. *Heat Treating & Forging,* Vol. 21, July 1935, pages 327-328. Electric Auto-Lite Company, Toledo, O., carburizes clutch pinions, bodies, and housings in full-muffle, batch-type gas carburizers, using the Eutectrol process. Bodies are of SAE 4620 steel, weigh 6 oz. each and are given a case depth of 0.028″. They are heated to and held at 1700° F. for 4½ hrs. while being subjected first to an atmosphere of reformed city gas flowing through the muffle at a rate of 35 ft.^{3}/hr. for a definite time, then raw natural-gas at 80 ft.^{3}/hr. for a definite time, and finally both reformed gas and natural gas at the same rates for the balance of the cycle. Rate of carbon penetration at 1700° F. is .012″/hr. Gross furnace load is 1146 lb. while net load is 567 lb. Cost of treating a lb. of work is $0.00518. About 37 ft.^{3} of city gas per hr. are required. About 1½ ft.^{3} of carburizing gas are required per lb. of work. MS (5e)

6. FURNACES, REFRACTORIES AND FUELS

M. H. MAWHINNEY, SECTION EDITOR

Oxygen for the Blast Furnace. J. R. MILLER. *Blast Furnace & Steel Plant,* Vol. 23, June 1935, page 413. Use of pure O_2 for blast would produce higher tuyere zone temperatures than hot-blast air, but there would be a smaller amount of resulting gases to carry heat and a greater amount of heat would be carried away by products of hearth. It would entail consumption of more coke, production of more and better top gas, and availability of more of top gas for fuel. It is possible that injection of proper quantity of steam would not only control combustion temperatures, but would also provide for carrying heat to upper zones of furnace, O_2 of steam replacing a certain amount of O_2 in blast, and H_2 going to top gas and acting as additional heat carrier. Operation might be so controlled as to maintain temperature gradients in furnace comparable to those now prevailing with hot-blast air. It would be necessary to charge sufficient additional coke to provide for dissociation of steam and an additional 150 lb. of coke per ton of Fe produced to make up for overall heat deficiency. Based on these assumptions, calculates that maximum permissible cost of O_2 is .006 cents per cu. ft. if cost of Fe is to be kept at or below cost of Fe produced by hot-blast air. MS (6)

Heat Theory, Radiation, Load Losses, Absorption and Other Factors. C. F. MAYER. *Industrial Heating,* Vol. 2, May 1935, pages 261-263. Results of a number of tests on various insulating materials and oven constructions and influence of wall thicknesses are described. Ha (6)

Low-Cost Oxygen for Metallurgical Operations. THEODORE NAGEL. *Mining & Metallurgy,* Vol. 16, Sec. 1, May 1935, pages 215-216. Concerned with the advantages of constructing large O manufacturing plants for use of O in metallurgical operations by eliminating the cost of transportation, storage and service. Improvements in air liquefaction and rectification have reduced the cost of power in O production; also plant equipment is less. Production of O of 95% purity, on the site of consumption can provide gaseous O at cost of $3.50 per ton at ½c per kw.-hr. and at $5 per ton with power at ¾c per kw.-hr., producing 150 tons daily from 50 ton units. Includes a table giving comparative values of different fuels, based on 5,000,000 B.t.u. input to open-hearth furnace; furnace temperature increased by use of O enriched air. VSP (6)

Rammed-in Linings for Cupolas (Austampfmassen für Kupolöfen). ALFRED BORSCH. *Feuerungstechnik,* Vol. 23, Apr. 15, 1935, pages 41-43. Fire clay brick has been replaced (about 70% in Germany) by rammed-in cupola linings incorporating ground SiO_2 and clay as binding agent. Advantages are the low initial costs, ease and low cost of installation by unskilled labor, absence of joints, patching up with identical material. Stresses occurring in vertical and horizontal direction are absorbed by the less sintered lining regions at the outside and top of the cupola. WH (6)

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Sesci Rotary Melting Furnaces. *Machinery,* London, Vol. 46, July 4, 1935, pages 421-422. Description of the furnaces which are used for high melting temperatures and accurate analysis melts which are free from oxidation. They are used for remelting gray Fe, white Fe, both white and black heart malleable, steel and alloys. They are being used as feeders of hot synthetic Fe for open hearths for producing refined pig Fe, melting additions to large open hearth furnaces. WB (6)

Developments in High Frequency Furnace Design. *Machinery,* London, Vol. 46, July 25, 1935, pages 511-512. Frequencies needed for induction furnaces with simple hearth form lie between 300 and 10,000 cycles; the latter for smaller furnaces and the lower frequency for large furnaces. Generation of reactive power by rotating converters was uneconomical and the advent of lower priced, dependable static condensers put high frequency furnace on higher competitive scale because the cost of the idle KVa's is a fraction of the cost of converters. The current for high frequency furnaces is now generated almost exclusively by rotating machines and the practice of A.E.G. is cited in employing the standard types used for normal frequencies for furnace current frequencies below 1000 cycles. For frequencies higher than 1000 standard homopolar generators of the type formerly built for wireless purposes are employed which can be brought up to 20,000 cycles. Krupp has furnaces of 4 to 8 ton capacity with the body of the furnace designed as a closed vessel, the magnetic fields being screened from the interior vessel. WB (6)

Use of Controlled Atmospheres in Production Heat Treating & Forging. R. J. Cowan. *Steel,* Vol. 96, Apr. 22, 1935, page 40. Abstract of paper read before tri-chapter meeting of Cincinnati, Columbus, and Dayton chapters of American Society for Metals, Apr. 15, 1935. Good annealing can be done in a controlled atmosphere open-fire furnace. Suggests use of controlled atmosphere in furnace cooling zone to prevent discoloration of Cu after bright annealing at usual annealing temperature. Predicts promising future for radiant tube furnaces, which use no baffles. Combustion takes place within tubes made of 28% Cr-12% Ni alloy, and combustion products do not come in contact with furnace charge. MS (6)

Quartz Sand in Silica Bricks. P. Budnikoff. *Sands, Clays & Minerals,* Vol. 2, June 1935, pages 85-88. Silica bricks made from quartz sand were found more unstable in steel furnaces than made from other materials, especially under strong fluctuations of temperature. Experiments are described from which it developed that a high grade silica brick can be made by introducing into the mix up to 35% of sand which must be ground previously and by addition of molasses to the mix. Ha (6)

Refractories in the Foundry. H. C. Biggs. *Foundry Trade Journal,* Vol. 52, May 23, 1935, pages 351, 352, 354. Paper read before Edinburgh Section of Institute of British Foundrymen. Fireclays, service behavior of firebricks, spalling, slag attack of refractory material, plastic refractories, rammed and bricked linings, bonding materials, etc. are discussed. AIK (6)

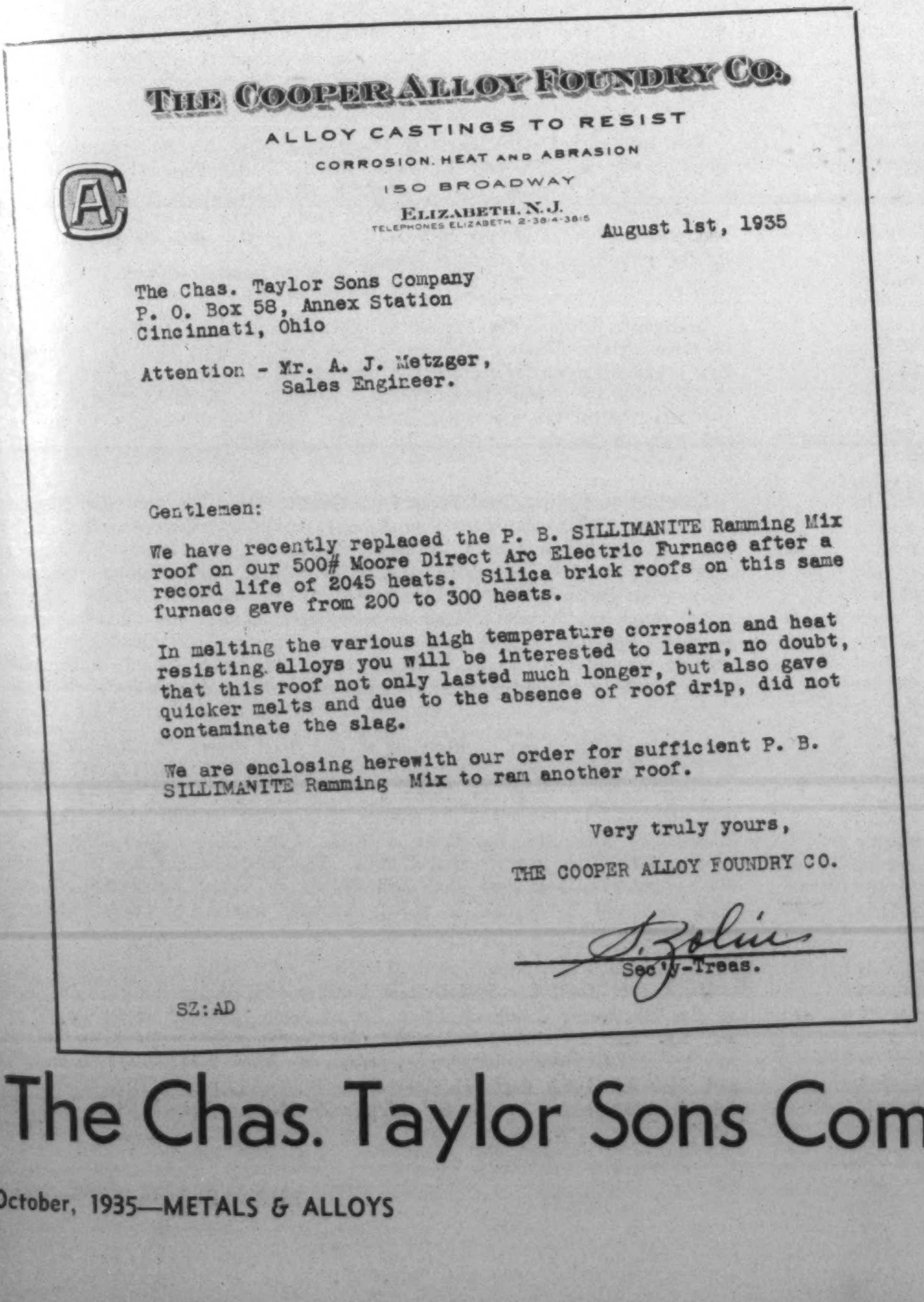
The Burning of Magnesite Bricks. Part III. J. H. Chesters, G. L. Clark & K. C. Lyon. *Transactions of the Ceramic Society,* Vol. 34, Apr. 1935, pages 243-249. Laue diffraction patterns were obtained from magnesite specimens in order to derive an estimate of the grain and crystal size, by comparing the spot sizes for mono and poly-crystalline specimens. GTM (6)

Fundamental Combustion Data Trace Path to More Efficient Use of Industrial Gas. E. O. Mattocks. *Steel,* Vol. 96, June 10, 1935, pages 30-33, 64. Discusses some important results of investigations carried out in testing laboratory of American Gas Association. Repression of dissociation of CO_2 and H_2O in products of combustion (when temperature of gas is sufficiently high) can be accomplished by mixing with the gas prior to combustion a requisite quantity of air in excess of that required to burn the gas completely. It may be done also by preheating combustion air and by operating furnace under pressure. High temperature of flue gases can be reduced to desired temperature with corresponding saving in amount of gas burned by making work chamber wall serve as part of combustion chamber wall. Work will then be heated by radiation as well as by convection. Turbulent burner affords greater heat transmission and permits complete combustion of larger quantities of gas/ft.^{3} combustion space. With nozzle-mixing burner, length of flame can be easily controlled and considerably less gas can be burned/ft.^{3} combustion space. MS (6)

Heating a Rolling Mill Pusher Furnace by Non-Luminous Flames (Chauffage d'un four poussant de laminoir par flammes non éclairantes). Poupet. *Chaleur et Industrie,* Vol. 16, Mar. 1935, pages 134-139. Detailed study of the heat distribution in a reheating furnace, raising 20 metric tons of blooms/hr. to 1260° C., fired by a mixture of blast furnace and coke-oven gas. Three sources of heat transfer are radiation from arch or hearth, radiation from flare, and convection. These equal 2,500,000; 980,000; and 470,000 calories/hr. respectively. JCC (6)

Electric Heat in the Non-ferrous Metal Industry (Elektrowärme in der Nichteisenmetall-Industrie). Knoops. *Elektrowärme,* Vol. 5, July 1935, pages 151-155. The economical advantages of electric furnaces are pointed out, melting furnaces for melting non-ferrous metals described. For melting brass, Cu, bronze, induction and high-frequency furnaces are most favorable; the average energy consumption for brass is 220 kwh., red brass 290 kwh., Ni silver 300 kwh., Cu 300 kwh., Cu-Ni alloys 630 kwh. and Ni 900 kwh./ton for a charge of 600 kg. Induction furnaces for Zn of 3 tons/hr. consume 100 kwh./ton. For intermittent operation arc furnaces can be used for about 1000 kg. charge with approximately the same energy consumption as before 8 hr. operation and 10-12% less for 24 hr. operation. Annealing is done in furnaces with air circulation; Cu strips are bright annealed by dipping the strips in water before heating when the evaporating water replaces the air and keeps the material bright. A few furnace types are illustrated. Ha (6)

New Light Weight Refractory Concrete. N. J. Kent. *Heat Treating & Forging,* Vol. 21, July 1935, pages 343-344, 349. Describes properties of "Firecrete." See *Metals & Alloys,* Vol. 6, July 1935, page MA 311. MS (6)



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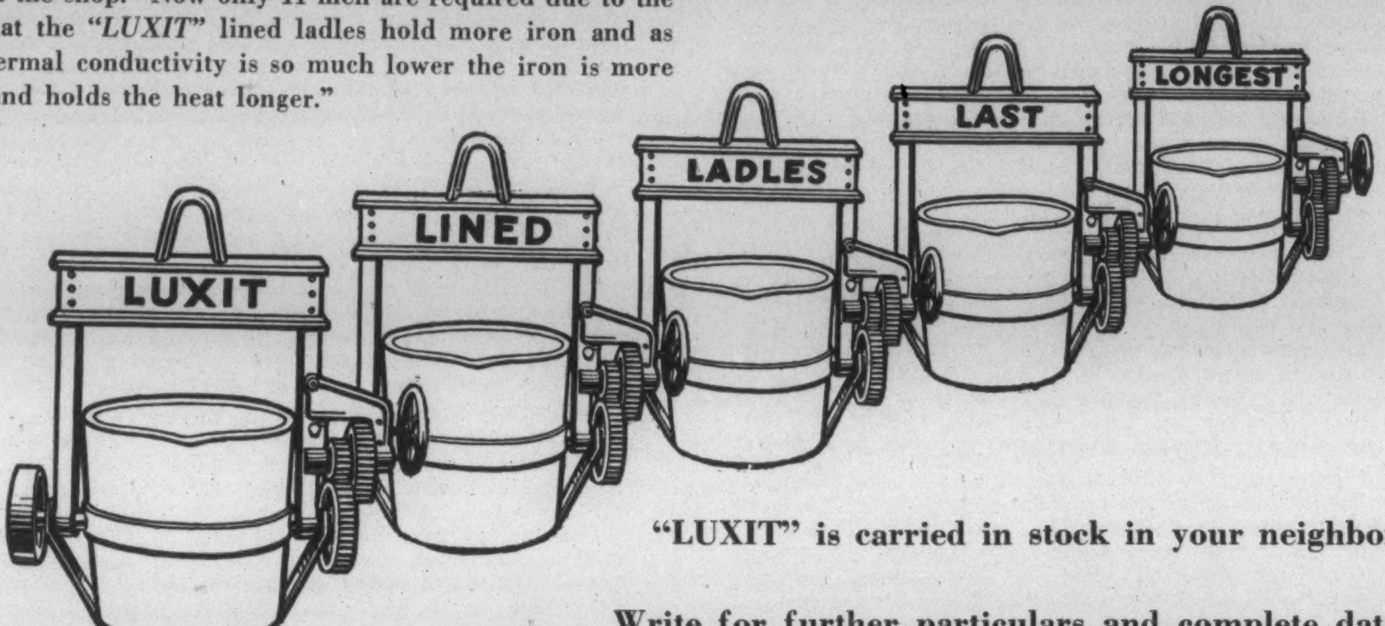

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Heat Insulation of Electric Furnaces (Wärmeschutztechnische Betrachtungen über den Aufbau eines Elektroofens). Otto Krebs. *Feuerungstechnik,* Vol. 23, May 15, 1935, pages 54-55. In electric furnaces, an adequate heat insulation must be provided for. The insulating efficiency of 2 different furnace walls is calculated in detail for (a) 12 cm. chamotte + 12 cm. Sterchamol bricks, (b) 6 cm. chamotte + 6 cm. Sterchamol bricks + 12 cm. diatomaceous earth shell. Lowering the heat gradient of 800° ⟶ 72° C. for (a) to 800° ⟶ 60° C. for (b) reduced the heat losses for 300 days from 3456 R.M. to 1944 R.M. WH (6)

Purpose and Operation of Furnaces for Temperatures up to 500° C. (Aufgaben und Betrieb von Oefen für Temperaturen bis 500° C.). U. Riegger. *Elektrowärme,* Vol. 5, July 1935, pages 155-161. Economic and hygienic advantages of electric furnaces, particularly for temperatures below 500° C., are illustrated by examples of nitriding plants, Pb melting furnace, galvanizing baths, oil aging and salt baths, ceramic cooling kilns, air heating installations, melting of type metal in printing plants, etc. Ha (6)

Magnesite and Magnesite Bricks. C. L. Rigby. *Sands, Clays & Minerals,* Vol. 2, June 1935, pages 99-104. The deposits of magnesite or carbonate of magnesia, $MgCO_3$, its production and application as refractory material in steel works are discussed. The raw magnesite is sintered and loses about half its weight at 700°-800° C. For making bricks the material is ground to a grain size of 0.2-0.3 mm. They are pressed under 250-260 tons and have high resistance to corrosion by slags. They are fired at temperatures between 1600° and 1750° C. for 40-50 hrs. according to resistance and density required and slowly cooled. The average composition is MgO 85-90%, Fe_2O_3 5-8%, Al_2O_3 0.5-1.5%, CaO 1.5-3%, SiO_2 1.5-3%, m.p. 2000° C., sp.gr. 3.60-3.65, porosity 15-20% by volume, crushing strength 800-900 kg./cm.², squatting at about 1650° C., collapse at about 1800° C., expansion at 1000° C. about 1%, at 1500° C. about 1.6%. The resistance against corrosion from basic slag is very good. Ha (6)

Properties and Applications of Modern Refractories. W. F. Rochow. *Chemical & Metallurgical Engineering,* Vol. 42, Feb. 1935, pages 76-80. Condensed from a paper presented before the Pittsburgh meeting of the American Institute of Chemical Engineers, November 16, 1934. By means of tables and graphs, data descriptive of refractories are given. Temperatures of reaction between different refractories are listed. PRK (6)

High Temperature Furnaces up to 3000° C. (Hochtemperaturöfen bis 3000° C.). A. Ruhstrat. *Elektrowärme,* Vol. 5, July 1935, pages 188-190. Furnaces for temperatures between 2000°-3000° C. consist of a C or graphite tube which is provided with suitable metallic terminals and heated directly by the electric current passing through the tube. Up to 100 kg. charge they are single-phase, for larger capacities the furnace is connected to the 3-phase supply by means of a 2-phase Scott transformer. A special thermostat was developed which permits regulation of ± 2° for a 1000° scale of the instrument. Ha (6)

How to Survey Our Plant for a Modernization Program. Herman A. Peterson. *Mill & Factory,* Vol. 16, Apr. 1935, pages 40-43; May 1935, pages 90-91. Relining of furnace lessened its gas consumption by 30%. New handling systems for raw materials, tools and supplies, standardization of grinding wheels, vacuum system for brass chip handling are discussed from the economic viewpoint. WH (6)

New Industrial Electric Furnaces (Neue Elektroöfen für die Industrie). *Feuerungstechnik,* Vol. 23, May 15, 1935, page 57. Describes and illustrates 2 new electric Siemens furnaces, one of which is characterized by a circulating furnace atmosphere and the other by a gas tight muffle. The former is intended for the heat treatment of Al and its alloys ($T_{max.} = 650$°C.) while the latter is designed for the carburizing and nitriding processes. WH (6)

Novel Raw Producer Gas Burners for Metallurgical Furnaces (Neue Rohgasbrenner für metallurgische öfen). *Feuerungstechnik,* Vol. 23, Apr. 15, 1935, pages 44-45. Raw producer gas carries considerable quantities of dust and tar and is not utilized in (Fe) burners without being cleaned. Recently 3 German burners appeared on the market which fire the raw producer gas. The burners designed by Ruppmann, and Huth & Röttger are illustrated and discussed. WH (6)

Evolution of Electric Steel Furnace Construction Since the War (Die Entwicklung des Elektrostahlofenbaues nach dem Kriege). Maase. *Feuerungstechnik,* Vol. 22, Apr. 15, 1934, page 50. Whereas the low-frequency furnace has been relegated from quantity production and while coreless high-frequency furnaces are still in development, attention is focused on arc furnaces. Diagrams are presented correlating furnace capacity to transformer capacity and interrelating weight of charge, melting-in time and transformer capacity. A critical discussion on graphite vs. carbon electrodes is made. Recent tendencies toward an improvement of the efficiency of electric steel furnaces are critically discussed. WH (6)

Analysis of Design and Construction of Hot Blast Stoves. Albert Mohr, Jr. & Fred Wille. *Iron Age,* Vol. 136, July 4, 1935, pages 12-17. Gives a scientific basis on which to design a hot blast stove having the best possible characteristics. Of paramount importance is structural stability which depends on thickness of brick, size and shape of brick, arrangement of brick fillers to form flues, and fractional checker around walls. Fractional checkers are to be avoided. Heat capacity of hot blast stove will depend on weight distribution of checker brick from top to bottom of stove. Includes number of graphs, tables and calculations. VSP (6)

The Use of Town Gas in the Steel Industry. H. Alex Fells. *Institution of Gas Engineers Communication* No. 87, June 1934, 87 pages; *Gas World,* Vol. 100, June 16, 1934, *Industrial Gas Supplement,* pages 8-16; Vol. 101, July 21, 1934, *Industrial Gas Supplement,* pages 9-11; *Gas Journal,* Vol. 206, May 30, 1934, pages 587-603; June 13, 1934, pages 776-779; Vol. 207, July 4, 1934, pages 36-39. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 566. AHE (6)

Recent Developments in Manufacturing and Using Refractories. Lewis J. Trostell. *Chemical & Metallurgical Engineering,* Vol. 47, July 1935, pages 363-367. Recent developments and trends in processing refractories are given. Properties, applications in ferrous and non-ferrous melting and elsewhere are given. PRK (6)

Anticipating Future Demands Upon Continuous Heating Furnaces. H. T. Watts. *Steel,* Vol. 96, June 17, 1935, pages 30-34, 58. Capacity of continuous furnaces for heating slabs and billets can be increased greatly by increasing rate of heat transfer to steel in back end of furnace. This could be accomplished by firing from both ends and having a waste port at center of furnace through which waste gases can pass to a recuperator or regenerator. Another idea is to use the countercurrent principle. This would involve division of furnace into 2 or more compartments in tandems, each acting as a separate continuous furnace with its separate air and gas supply and waste gas port. In ideal furnace, primary consideration is transfer of heat to steel, available heat transfer in any section is limited only by ability of steel itself to conduct heat throughout its cross-section; highly developed mixing and proportioning burners permit control of combustion and heat liberation in any section at will, without affecting conditions in any other section; heat conserving apparatus reduces waste gas heat loss to nominal quantity, wall and roof thermal losses are reduced to a minimum by suitable brick; and use of H_2O-cooled skid pipes is obviated. MS (6)

Electric Furnaces in Industrial Heat Treating. A. Glynne Lobley. *Heat Treating & Forging,* Vol. 21, Mar. 1935, pages 148-149. Condensed from *Metallurgia,* Vol. 11, Jan. 1935. See *Metals & Alloys,* Vol. 6, June 1935, page MA 230R/4. MS (6)

Application of Insulation Refractories to Industrial Furnaces. J. D. Keller. *Heat Treating & Forging,* Vol. 21, Mar. 1935, pages 144-147. Reprint of *American Refractories Institute Technical Bulletin,* 53. These new refractories are used chiefly in intermittently operated furnaces such as forge, hardening, annealing, heat-treating, and strain-relieving furnaces. Savings in time and fuel used for heating up are 70-85% as compared with a fire-brick furnace. Savings shown amount to several hundred % on the additional investment. Most troublesome drawback is spalling. Gas leakage can be reduced greatly by a thin coating of dense, finely-ground high-temperature cement on inner surface. In most cases use of mortar for laying brick is preferable. These refractories are well adapted for use as suspended roofs and are especially desirable in the covers of soaking-pits. Generally, they are not to be used in hearths. MS (6)

Heat Transmission Through Bare and Insulated Furnace Walls. R. H. Heilman. *Chemical & Metallurgical Engineering,* Vol. 41, Dec. 1934, pages 637-641. By means of tables and charts and examples, methods of calculating heat transmission are given. PRK (6)

Electrodynamic Phenomena in Electric Furnaces with Particular Regard to the Low Frequency Induction Type (Sui fenomeni elettrodinamici nei forni elettrici con particolare riguardo a quelli a induzione a bassa frequenza). R. Piontelli. *La Metallurgia Italiana,* Vol. 27, June 1935, pages 419-437. Mathematical, with discussion of Pinch effect, Corner effect, etc., in various types of commercial low frequency induction furnaces such as the Kjellin, Frich, Colby, Rodenhauser, Ajax, etc. AWC (6)

Soaking Pits. G. R. McDermott. *Iron & Steel Engineer,* Vol. 12, June 1935, pages 369-371. Discusses temperature control on soaking pits. WLC (6)

Automatic Control of Metallurgical Furnaces. J. K. Mawka. *Blast Furnace & Steel Plant,* Vol. 23, July 1935, pages 475-476. Where furnace conditions have been previously determined correctly in accordance with good practice, automatic control will improve materially results of any furnace operation. Furnace pressure regulation gives the most apparent improvement in operating results and has received greatest recognition from furnace operator. Control of fuel and air flow is being applied with marked success where adequate means are available for securing a true measure of these quantities. On many older furnaces it cannot be applied to its fullest extent due to serious air leakage. Application of controls to some of these older furnaces has demonstrated the inadequacy of these designs. Equipment for regulation and metering is simple in design, accurate and dependable. It is desirable to have automatic control and metered results dissociated and not performed by the same units, so that each may be used as a check on the other. MS (6)

Relations Between Density, Liquidity and Attack on Fireclay Bricks of Glasses and Slags at High Temperatures (Ueber die Beziehungen zwischen Dichte, Flüssigkeitsgrad und Schamottsteinangriff von Gläsern und Schlacken bei hohen Temperaturen). K. Endell & C. Wens. *Glastechnische Berichte,* Vol. 13, Mar. 1935, pages 78-86. Slags of blast furnace and copper melting processes, and liquid glasses were investigated experimentally. The very exhaustive description of methods for measuring density and liquidity should be read in the original; the results are in brief: density of glasses and slags decreases steadily with increasing temperature, at 1400° C. it is about 10% below the density at 20° C. That attack of molten glasses and slags on fireclay and silica bricks increases with the degree of liquidity and is almost independent of the composition of the attacking materials. The dissolved material is carried away from the still solid material in a measure which depends on the sp.gr. of the slags or glasses, as the energy increases with density. Liquidity and density of the attacking materials accelerate at high temperatures the concentration equilibrium between refractory bricks and glass or slag; a very strong attack starts only after reaching a liquidity corresponding to a dynamic viscosity of 35 c.g.s. units or a kinematic viscosity of 10 at an average density of 3. 14 references. Ha (6)

Natural Gas in Steel Plants. Karl Emmerling. *Iron & Steel Engineer,* Vol. 12, June 1935, pages 337-341. Descriptive of furnace designs using natural gas. Discussed at Youngstown meeting of A.I. & S.E.E., Apr. 1935. WLC (6)

Power Loss and Voltage Drop in Circuits of Electric Furnaces (Perdite di potenza e cadute di tenzione nei circuiti dei forni elettrici). E. Donati. *La Metallurgia Italiana,* Vol. 27, May 1935, pages 341-355. Mathematical. AWC (6)

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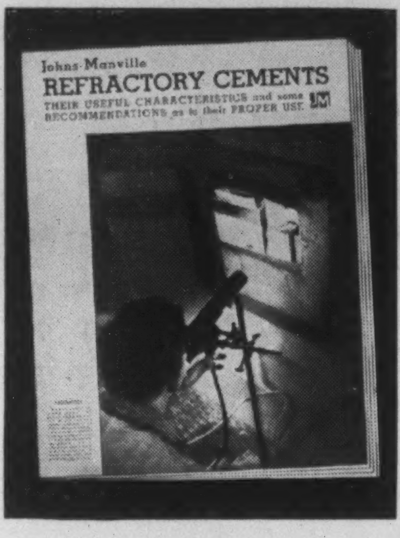
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The Temperature History and Rate of Heat Loss of an Electrically Heated Slab. ALBERT B. NEWMAN & LOUIS GREEN. *Transactions Electrochemical Society,* Vol. 66, 1934, pages 345-358. If a slab of homogeneous material is subjected to a heat input at a constant rate into one face while the other face is exposed to a fluid medium, the ratio, rate of heat loss to the medium to rate of heat input, will vary from zero at the start to unity after a steady state has been reached. The temperatures of both faces will rise until the final steady values are attained. If the heat supply is cut off at some instant, either before or after the steady state is reached, the slab eventually will cool down to the temperature of the fluid medium, but the temperature history of the two faces would be difficult to predict without mathematical analysis. A practical case is that of an electric furnace being heated up to a desired temperature by means of a uniform kilowatt input, and then being allowed to cool down after the heat supply is discontinued. In this case the temperature history of the inner face of the wall could be taken approximately as the temperature history of the furnace, and the temperature of the fluid medium would be that of the air in the room. This paper presents a mathematical analysis of the general case, and the results are translated into tabulated values and curves for application to practical cases. (6)

Heating for Coiling and Toughening Springs. J. B. NEALEY. *Heat Treating & Forging,* Vol. 21, June 1935, pages 295-296, 303. Same as *Steel,* Vol. 95, Dec. 31, 1934, pages 16-18. See *Metals & Alloys,* Vol. 6, June 1935, page MA 230 L2. MS (6)

Industrial Propane Used for Bright Annealing. W. Z. FRIEND & F. LECKIE. *Iron Age,* Vol. 136, July 25, 1935, pages 30-32. Industrial propane is used to prepare the special atmosphere in combustion-type, furnace atmosphere controllers at the plant of the Rotary Electric Steel Co., Detroit. Bright annealing strip steel is accomplished in a continuous car-bottom furnace of the company's own design. Atmosphere used is provided by mixing and burning air and propane in the ratio 16 volumes of air to 1 of propane. Atmosphere gases are introduced to the pots after they have been in the furnace 2 hrs. and have been brought up to a temperature of about 1400° to 1500° F. Each pot remains in furnace 7 hrs. Atmosphere gas is continuously circulated through annealing pots. Propane is stored in liquid form. It is used as fuel in large number of industrial heating processes. VSP (6)

Design of Balanced Blast Cupola. F. J. COOK. *Foundry,* Vol. 63, June 1935, pages 32-33, 72. Describes a new design of melting furnace introduced by the British Cast Iron Research Association. The principle of operation is that of controlling the air supply at the main tuyeres. Results obtained are due not only to use of valved tuyeres, but also to number, size and distribution of both upper and lower tuyeres. Advantages claimed are: (1) Reduced coke consumption, 20 to 4%, and diminished S pickup; (2) Metal of a high temperature at spout, 2550°-2650° F. throughout melt; (3) Hot metal from beginning to end of melt; (4) Fe comparatively free from oxidation; (5) Rapid removal of frozen slag without poking; (6) Successful melting of charges having large proportion of steel scrap; and (7) Reduction in scrap and deflective castings. VSP (6)

7. JOINING

Contribution to the Investigations of Autogenous Joints of Aluminum with Other Metals (Beitrag zu den Untersuchungen der Autogenverbindungen von Aluminium mit anderen Metallen). HOLLER & MAIER. *Autogene Metallbearbeitung,* Vol. 28, June 15, 1935, pages 177-178. Contrary to widely held views experiments proved that welds of high strength can be made between Al and other metals, and that welds or brazed joints possess an even higher resistance against corrosion than soft soldered joints. Joints of Al with Fe in wire or sheet form can be obtained by first coating the Fe thinly with tin solder and removing every trace of flux. The flame should heat the Fe more than the Al. A tensile strength in the joint of 6-7 kg./mm.^{2} can easily be obtained. Joints of Al with Cu are more difficult, the Cu should first be coated with Al by using a proper flux, e.g. autogal. With 5 mm. thick sheets tensile strength of 2-5 kg./mm.^{2} were found; soft soldered joints with tin solder showed 4-5 kg./mm.^{2} The latter gives here better results than welding, the Cu is first coated with tin solder. Joints of thin sheets have greater strength than of thicker sheets. Al and brass can be welded easier than Al and Cu, the brass must be thinly coated with a metal, e.g. an Al soft solder, but not tin solder. A small flame should be applied. The tensile strength is 3-4.5 kg./mm.^{2} for Al soft solder, 1-5.5 kg./mm.^{2} for pure Al coating, and 2.5-5 kg./mm.^{2} for Ag solder. The best joints of Al with Ni and Monel metal are made by first tinning the Ni or Monel metal. The tensile strength is 6.5-8.5 kg./mm.^{2} for 5 mm. thick sheets of Ni, and 3.3-4.5 kg./mm.^{2} for Monel metal of 5 mm. and 8-10 kg./mm.^{2} for 1 mm. thickness. Pb can be welded with Al without a flux using a Pb wire and coating the Al first with Al soft solder. Al and Zn can be welded with a Zn wire with particular precautions. Al must first be coated with Al soft solder. The tensile strength is 4.5-6 kg./mm.^{2} for 3 mm. thick sheets. The procedures for each case are described in detail, structures shown in micrographs, and fluxes and type of welding pencil to be used given. Ha (7)

Aluminum Conductor Joints in Electric Cables (Aluminium-Leitungsverbindungen in Starkströmkabeln). L. LUX. *Aluminium,* Vol. 17, Apr. 1935, pages 202-208. Joints between Al and Al, and Al and Cu conductors are made by welding or hard-soldering, by soft-soldering, pressure joints or by clamps. The first type gives the most satisfactory joint mechanically as well as electrically. Autogenous welding can be used only for Al to Al, resistance welding and hard soldering also for Al-Cu. Methods, fluxes, preparation of ends, mechanical joints are described and examples shown. Ha (7)

Joining of Light Metals by Welding and Soldering (Verbindung von Leichtmetallen durch Schweissen und Löten) *Metallwaren-Industrie & Galvano-Technik,* Vol. 32, Oct. 1, 1934, pages 434-435. Discusses soft soldering, brazing, fusion welding, hammer welding, resistance welding, and spot welding of Al and Si alloys. EF (7)

Cable Joints for Aluminum Transmission Lines (Die Seilbunde bei Aluminium-Freileitungen) P. BEHRENS. *Aluminium,* Vol. 17, May 1935, pages 253-256. The different ways to make electrically and mechanically satisfactory joints between cables of Al high-tension lines are discussed and illustrated. Ha (7)

7a. Soldering & Brazing

Design of Aluminum Parts Suitable for Soldering (Beitrag zum lötgerechten Konstruieren von Aluminiumteilen). E. LÜDER. *Aluminium,* Vol. 17, June 1935, pages 315-316. When an Al part in a repair job has to be joined to a brass part it is best in order to prevent eventual later corrosion to replace the brass part by one of pure Al or an Al alloy and to join the two by a hard solder rich in Al. Proper shaping of the joint and procedure are illustrated by an example. Ha (7a)

"Lumisold" and "Aiagin Soldering Paste," Two New Solders for Soft-Soldering of Aluminum and Aluminum Alloys ("Lumisold" und "Aiagin-Lötpaste," zwei neue Lötmittel zum Weichlöten von Aluminium und Aluminiumlegierungen). M. BOSSHARD. *Aluminium,* Vol. 17, June 1935, pages 319-321. Soft solders for Al alloys must have such low m.p. that the properties of the cold-worked or hardened materials are not destroyed in soldering by softening. Among a great number of experiments, Lumisold, a mixture of $KCl + LiCl + AlF_3 + ZnCl_2$, with a m.p. of 350° C. and Aiagin, a mixture of $SnCl_2 + KCl + NaCl + ZnCl_2 + NH_4Cl$, with a m.p. of 175° C. were found satisfactory. Although the joints made with these solders are mechanically satisfactory they are, as all soft soldered Al joints, not very corrosion resistant. Lumisold should be used where softening of the material is of no importance and welding impossible or too expensive; Aiagin can be advantageously applied for joining small parts, as hinges, needles, or for making containers tight for oil, benzene, etc., by putting it along the seams. They can both be used for joining Al to other metals. Ha (7a)

Continuous Electric Brazing in Controlled Atmospheres. A. G. ROBIETTE. *Machinery,* London, Vol. 46, May 16, 1935, pages 193-196. Tightly fitting parts with clearance of the order of .003-.004″ are required in order for capillarity to draw in the molten braze. The brazing metal must wet the surface of the parts to be joined and must have a low solid solubility in the metal of the parts in order to prevent rapid diffusion. A joint brazed with Cu by the method has a shear strength of 20-24 tons/in.^{2} The braze is usually applied as a wire fastened to the parts and which melts and flows down into the capillary space. Where wire cannot be used a paint made of brazing metal powder and cellulose binder is brushed or sprayed on the joint. W and rare metal contact points and cemented carbide lathe tools are produced by the method. Costs are lower than for welding, other methods of brazing, riveting and soft-soldering. Steel parts Cu brazed by the method have an anneaeled structure with fairly large grain size due to heating to above 1100° C. which the method requires. Parts can be normalized or hardened after brazing. The furnace atmosphere is produced either by cracking NH_3 and mixing with air or partially burned coal-gas, or butane is used in a mixture with air. WB (7a)

Instructions for Soldering Aluminum. *Compressed Air Magazine,* Vol. 39, Oct. 1934, page 4558. The difficulties in soldering Al are due to the oxidized surface. As commercial Al and most of its alloys contain more or less Si, cleaning with HF or solutions developing that acid is recommended. This is followed by careful washing in H_2O and dipping into alcohol, preferably methanol. If no corrosion resistant properties are required, a solder alloy of 85% Sn and 15% Al is suitable, whereas a 90% Al, 9% Cu and 1% Ag solder insures corrosion resistance according to experiments at the Technological Institute at Stockholm. WH (7a)

Hard-Soldering of Ferrous and Non-ferrous Metal Parts and its Importance for Foundries (Hartlöten von Eisen- und Nichteisenmetallen und seine bedeutung für die Giesserei) ERICH BECKER. *Giesserei,* Vol. 22, Apr. 26, 1935, pages 195-198. Advantages of hard-soldering with the oxyacetylene flame not only for repairing but also for joining parts in place of welding are discussed, the lower temperature being especially advantageous as the joint can more easily be made free from pores and interior stresses. The solder for cast Fe is usually a mixture of 60% Cu and 40% Zn; addition of 1% Sn, 1-1.5% Fe, or about 1% Mn, and particularly Si, increases the strength of the soldered place. Pb is always harmful and makes the soldered joint porous and brittle. Alloys of Cu-Ni are also used. They give a color resembling cast Fe and are more heat-resisting than brass. Al is hard-soldered with solders containing 70-95% Al and additions of Cu, Zn, Sn, Si, Ni, Mn, Cd, Ag; they are applied at 550°-630° C. while Al is welded at 660° C. Ni and Ni alloys are soldered with German silver and silver solders with low Zn content and Ni of such amount that they have a white color; melting temperature should be between 700° and 800° C. Best procedures and fluxes are discussed with particular regard to work occurring in foundries. 16 references. Ha (7a)

Hard Soldering of Stainless Steel Members with Silver Solder (Zum Hartlöten von nichtrostenden Stahlartikeln mit Silberlot) EDMUND T. RICHARDS. *Die Metallbörse,* Vol. 24, Dec. 22, 1934, page 1627. In general, the qualities of Ag solder are improved with increasing Ag contents. The following solders are recommended for German silver and Ni tubes: 75 Ag, 17 Cu, 8 Sn, for thin-walled Cu and brass members: 65 Ag, 24 Cu, 11 Zn and for heavy brass parts: 30 Ag, 40-50 Cu, 20-30 Zn. It is remarkable, that the most suitable Ag solders for austenitic stainless steels contain but 10% (15% max.) Ag and 50-60% Cu, 3% Ni, balance Zn. Na favorably affects strength, corrosion resistance and alloying properties. The most suitable soldering temperature range is 875°-900° C. The melting point of the Ag solder can be adjusted by varying the Cu and Zn concentration. The solder paste should contain 10-20% boric acid and 10-15% $ZnCl_2$. The boric acid must be remelted to remove the H_2O content. Borax, boric acid and Zn-chloride are ground dry and made into a paste by gradually adding alcohol. EF (7a)

Notes on the Fabrication of Sheet Metals—II. Soldering and Brazing. A. J. T. EYLES. *Sheet Metal Industries,* Vol. 9, Jan. 1935, page 34. A very brief discussion of soft solders and their fluxes and of brazing with appropriate fluxes. AWM (7a)

Effect of Foreign Metals on the Physical Properties of Solder (Einfluss der Fremdbestandteile auf die technologischen Eigenschaften des Lötzinns) EDMUND RICHARD THEWS. *Die Metallbörse,* Vol. 24, Dec. 15, 1934, pages 1593-1594; Dec. 22, 1934, pages 1625-1626. The author sets out to prove that Sb and Cd do not represent a contamination in Sn-Pb solders as assumed for the former metal. The efficiency of solders is not based on adhesion but on diffusion and alloying between solder and joined metal. The intelligent selection of a solder according to service conditions to be met with (atmospheric corrosion, mechanical stresses, elevated temperatures) is discussed. According to the German standards (DIN) a ratio of 3.6 Sb : 54.4 Sn is allowed for German solders. In this ratio, Sb is not considered injurious. Sb reduces fluidity and plastic properties, but improves strength and wear resistance. Within the above limits, no embrittlement takes place. Due to permanent exposure to steam on moist air, Sb contents are liable to slightly reduce corrosion resistance. The same effects as exerted by Sb hold for Cu. 0.05% Cu notably improves strength without affecting elongation. Up to 3% Cu is admitted for soft solders for soldering Zn and galvanized parts. For this specific purpose, the diffusion properties are greatly improved by Cu. Detrimental in every respect are Zn and As. 0.01% Zn causes the formation of oxide films which prevent an intimate contact between solder and jointed metal and corrosion is accelerated greatly. With 0.05% Zn present, a soldered joint can be pulled apart by hand. The harmful effect of As is less pronounced. EF (7a)

Special Atmospheres in the Heat Treatment and Brazing of Metals. C. L. WEST. *Iron Age,* Vol. 135, May 16, 1935, pages 18-22, 86. Describes special gases developed by the Electric Furnace Co., Salem, O., known as Elfurno gases. Elfurno gas atmosphere is produced by combustion of carbonaceous gases suitably proportioned with quantities of air in a special gas producing apparatus and properly controlled temperature. Cost of production ranges from 10 to 20c per 100 cu. ft. Several types of furnaces use Elfurno gas. Ferrous and non-ferrous metals can be brazed and bright annealed. VSP (7a)

Soldering Aluminum (La saldatura dolce dell'alluminio). E. ZURBRÜGG. *Alluminio,* Vol. 4, Mar.-Apr. 1935, pages 106-108. The common methods of soldering Al are described. AWC (7a)

Use of Controlled Atmospheres in Joining of Metals. H. M. WEBBER. *Steel,* Vol. 96, Apr. 22, 1935, page 39. Abstract of paper read before tri-chapter meeting of Cincinnati, Columbus, and Dayton chapters of American Society for Metals, Apr. 15, 1935. Discusses brazing in controlled atmosphere electric furnaces. Low-C steel is most common metal brazed. Various C and alloy steels are handled with comparative ease, but steels containing certain percentages of Cr, Al, and Si require special treatment. Cu is usually employed for brazing steel. Brazing furnaces are usually of the continuous or semi-continuous types. Most commonly used atmosphere is formed by partial combustion of natural-gas, coke-oven gas, C_3H_8, or C_4H_{10}. Mixture contains 20% H_2, 12% CO, 3% CO_2, and 65% N_2 and costs 10-50 cents per 1000 cu. ft. Steel passed through a reducing atmosphere in the brazing process has an increased tendency to oxidize and, in some cases, there is a tendency toward slight decarburization. Stainless steels are most difficult to braze. MS (7a)

WELDED MONEL METAL

Gustave Glaser Company, Inc., New York, recently built six welded Monel Metal plant trucks for a chemical manufacturer. All joints are metallic arc welded using INCO welding materials.

..by the "TRUCKLOAD"

THE trucks shown above are excellent examples of welded Monel Metal. There were six made on one order, and each had about 35 lineal feet of welding on it.

Yet in all the 210 feet of welding on this job, the fabricator reports there isn't a single flaw.

The trucks are built of sheet Monel Metal, No. 13 (.093") and No. 10 (.140") Gauge. Rod used was Monel Metal arc welding rod No. 30 (3/32").

While these trucks were built for a chemical plant, they are typical of welded Monel Metal equipment widely used in all types of industry.

* * *

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York, N. Y.

INCO WELDING RODS & FLUXES

for PURE NICKEL

Oxy-Acetylene . . . No. 41 Nickel Gas Welding Wire.
Metallic Arc . . . INCO Nickel Metallic Arc Welding Wire No. 31.
Carbon Arc . . . INCO Nickel Carbon Arc Welding Wire No. 21.

for MONEL METAL

Oxy-Acetylene . . . No. 40 Monel Gas Welding Wire. For flux see * below.
Oxy-Acetylene . . . No. 43 Silicon Monel Gas Welding Wire.
Metallic Arc . . . INCO Monel Metal Arc Welding Wire No. 30.
Carbon Arc . . . INCO Monel Carbon Arc Welding Wire No. 20.

for INCONEL

Oxy-Acetylene . . . No. 42 Inconel Gas Welding Wire. For flux see ** below.
Metallic Arc . . . Inconel Metallic Arc Welding Wire No. 32.

for NICKEL-CLAD STEEL
(for welding of Nickel side)

Oxy-Acetylene . . . No. 41 Nickel Gas Welding Wire.
Metallic Arc . . . INCO Nickel Metallic Arc Welding Wire No. 31.
Carbon Arc . . . INCO Nickel Carbon Arc Welding Wire No. 21.

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FLUXES

*INCO Gas Welding and Brazing Flux for Monel Metal.
**"Cromalloy" Gas Welding Flux is recommended for Inconel.
No flux is used for the gas welding of Pure Nickel or Nickel-Clad Steel.

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INCO welding materials as listed can most conveniently be obtained through regular INCO distributors.

Detailed welding instructions furnished on request.

Monel Metal is a registered trade-mark applied to an alloy containing approximately two-thirds Nickel and one-third copper. Monel Metal is mined, smelted, refined, rolled and marketed solely by International Nickel.

7b. Welding & Cutting

E. V. DAVID, SECTION EDITOR

Electric Arc Welding Bronze Overlays on to Steel. Charles H. Jennings. *Iron Age,* Vol. 136, July 4, 1935, pages 22-25, 178. Outlines fundamentals governing the deposition of bronze overlays on to steel as used on rocker rings for the new Pennsylvania class GG-1 locomotive motors. In depositing welding-bronze on steel the metals must be brazed and not fused together, and deposited bronze must be cooled quickly to prevent porosity as a result of liquation. With metallic arc process the surface of steel should be clean. Good results are obtained by depositing bronze on a dry machined or ground surface. After depositing the bronze, the rings are annealed at 1300° F. for 2 hrs. and shot blasted to remove all scale. VSP (7b)

Some Characteristics of the Welding Flux Affecting the Welding Arc. Haruhiko Shibata & Masao Koibuchi. *Tetsu-to-Hagane,* Vol. 21, Apr. 25, 1935, pages 234-242. In Japanese. The welding rod is directly and greatly influenced by the welding flux with which it is coated. Using about 30 kinds of ordinary fluxes, namely, carbonates and oxides of various metals, their effect on the characteristics of the electric arc was studied. The results were as follows: (1) When a metallic oxide is used as welding flux, there exists a definite relation between the atomic weight of the metal, the arc voltage and the melting ratio. (2) There is a definite relation between the arc voltage and melting ratio, irrespective of the type of welding flux. (3) Some welding fluxes show great differences between the arc voltage and melting ratio obtained by connecting the welding rod with the anode and that with the cathode. (4) The arc voltage and melting ratio vary according to the chemical composition, and physical properties of the welding rods. When the rods are coated with a definite kind of welding flux, however, the arc voltage and melting ratio show definite values depending upon the flux. (5) Any welding flux applied separately shows a definite arc voltage, which depends upon its polarity. The value of arc voltage, varying only with the flux, is quite free from the influences of the properties of the welding rod, amount of arc current and thickness of the coating of flux. TS (7b)

The Need for Standardization and Uniform Thought in Welding Subjects. O. Simonis. *Welding Journal,* Vol. 32, May 1935, pages 152-153. It is proposed to define welding electrode only as wire which has a metallurgically useful or other scientific coating that increases the gage of the wire by not less than 20%. There should be a universally accepted, distinct differentiation between bare wire, fluxed wire and electrode welding. Haphazard coloring of electrodes should be discontinued and suggested coloring is one for mild steel with tensile strength up to 28 tons/in.^{2}, another color for values above this; one color for cast iron leaving a hard surface and another for cast iron leaving a machinable deposit; others for Mn steels, stainless steels, etc. Forgeability tests for welding in structures has been neglected and should be investigated. Izod test for impact of all-weld metal is valuable but all other impact tests should be discarded. WB (7b)

Status of Resistance Welding Technique (Stand der Widerstandsschweisstechnik). E. Rietsch. *Zeitschrift Verein deutscher Ingenieure,* Vol. 79, June 29, 1935, pages 800-804. Recent progress in automatic spot-, seam- and butt welding processes is reviewed. The tendency is increase in heating energy at the weld and simultaneous reduction of welding time to prevent too much heat loss. Machines and arrangements to produce this effect are described, examples are shown. Ha (7b)

Preliminary Statement on the Mechanism of Chemical Reactions in Weld Metal. J. H. Patterson. *Welder,* Vol. 7, May 1935, pages 546-547, 575; *Welding Journal,* Vol. 32, May 1935, pages 134-135. Standard electrode was proposed for standardizing research work on welding in various parts of British territory. Mild steel wire with C .11-.13, Mn .35-.45, S .4 min., P .4 min., Si trace, was suggested and coating of 70 parts magnetic oxide (98% Fe_3O_4), 30 parts precipitated silica (99% SiO_2). Discussion of the N_2 content of weld metal shows that with the new types of rods, N_2 has been reduced to a max. of .025% which with previous rods could not get below .12%. The authors' opinion is that the N_2 enters the weld from a deposit rich in N_2 which is progressively formed and condensed in front of the electrode. Ha + WB (7b)

Arc Welding of Thin Sheet Metal. C. M. Taylor. *Sheet Metal Worker,* Vol. 26, Jan. 1935, pages 28-30. Methods and equipment to be used are illustrated by several examples on tanks, metal furniture, ducts. Ha (7b)

Welding of Structures in the Chemical Industry. C. O. Sandstrom. *Chemical & Metallurgical Engineering,* Vol. 42, Feb. 1935, pages 94-95. Progress made in the art of fusion welding is discussed. Changes in technique for welding brackets, columns and struts, trusses, towers and frames are given. PRK (7b)

Welding in the Chemical Engineering Industry. N. P. Inglis & W. Andrews. *Welder,* Vol. 7, May 1935, pages 566-570. Welding methods used on high tensile alloy and corrosion resistant steels and points to be observed to take care of certain peculiarities of these steels are discussed and illustrated by examples. Ha (7b)

Electric Arc Welding and Its Applications. M. Maurice Lebrun. *Welding Journal,* Vol. 32, June 1935, pages 168-171. First of a series of abstracts of "La Soudure Electrique a l'arc et ses Applications," a book by the above author which has been translated from the French for Welding Journal. The characteristics of the arc, experimental proof of metal transport in electric arc are discussed. Photographs of the mechanism of drop formation and transport to weld are shown for light and heavy coated electrodes. Formulas for calculating current for various size electrodes are presented for manual and automatic welding and table is given for current for various electrodes which are given in mm. WB (7b)

Positioning Steel Assembles for Welding. R. E. Kinkead. *Welding Engineer,* Vol. 20, July 1935, pages 29-30. Practical hints for advantageously placing welding work and a table showing the time to weld a certain amount of material at 20°, 45° and 90° (from the horizontal position) are given. Ha (7b)

The Welding of Cast Iron: Some Metallurgical Consideration. J. G. Pearce. *Foundry Trade Journal,* Vol. 52, May 9, 1935, pages 313-314, 316. Contributed to Symposium of the Welding of Iron and Steel. The properties of cast Fe which affect the success or failure of welds depend in the main on the C content. The effect of other elements is either direct or indirect through their influence on the C and its relationship to the Fe. The thermal conductivity of cast Fe depends on structure as well as composition. Cast irons subjected to elevated temperature in the presence of air tend to oxidize externally and internally (growth). While graphite may be responsible for some of the difficulty of welding cast Fe, it is more likely to be due to the combined C, the oxidation of which causes blowholes and gaseous inclusions. A ferritic iron should be more easily welded than a pearlitic iron. Preheating, by converting pearlite to ferrite, should facilitate welding, quite apart from its effect in reducing stress due to expansion and contraction, and avoiding chilling of the weld deposit. AIK (7b)

Steel Roof Nash "400" Bodies Mark Real Advance in the Welding Art. J. Geschelin. *Automotive Industries,* Vol. 72, June 29, 1935, pages 856-859. All-steel body construction with steel roof is combined with a steel underbody of light but very strong box sills. One pair of flash weld lines runs 104 in. to each side. Size of panels and alignment of welding dies are so controlled that no solder is used anywhere on the body. All body sheets are first passed through a roller-leveler and oiled, then pressed and welded. Equipment includes 126 automatic gun welders, 75 arc welders, 36 spot welding machines, 4 indirect and 9 special flash welders. More flash welding is used than usually found in similar work. A merry-go-round welding line is used in attaching braces, clips and other small parts in making the cowl units. BWG (7b)

Electric Arc Welding Plant. R. W. Happe. *Welder,* Vol. 7, June 1935, pages 606-607. Some notes on the selection of the most suitable equipment under given conditions. Ha (7b)

Straightening of Welded Pipes, Boilers and Profiles with the Acetylene Torch (Richten von geschweissten Röhren, Kesseln und Profileisen mit dem Azetylenschweissbrenner). H. Hennefeld. *Autogene Metallbearbeitung,* Vol. 28, July 15, 1935, pages 217-218. Description of a process in which preliminary internal stresses are imposed on the pieces. These stresses disappear after the heating due to the welding process. Ha (7b)

Portable Resistance Welding Installation of Large Capacity (Ortsbewegliche Widerstands-Schweisseinrichtung grosser Leistung). Johann Otto. *Zeitschrift Verein deutscher Ingenieure,* Vol. 79, June 29, 1935, pages 805-806. An installation on a railway or motor truck is laid out for welding or cutting sections of rails up to 10,000 mm.^{2}, with welding pressures up to 30 tons, contact pressure of electrode 5 tons, capacity 250 kva., continuous output 100 kw. Ha (7b)

Magnetic Flare and Arc Blow in Welding. R. Notvest. *Welding Engineer,* Vol. 20, May 1935, pages 24-26; June 1935, pages 32-35. The disturbances created in the electric arc through the influence of the magnetic flux of the circuit are explained and means to eliminate or minimize them are discussed. For any given electrode used on certain work, there exists an optimum point of current flow and consequent heat liberation for melting efficiency and metal deposition; these factors can be influenced by the magnetic field, the aerodynamic state of the surrounding atmosphere and the metallurgical composition of the electrode. The stability of the arc is promoted by a steep potential gradient at the cathode. The influence of a carbon electrode with reversed polarity, i.e., the carbon as anode, by strongly carburizing the surface of the weld is undesirable, and especially in overhead welding it is easier to make a weld with a 0.04-0.06% C and about 0.15% Mn electrode using straight polarity than using a 0.13-0.18% C, 0.4-0.6% Mn electrode of same diameter and same current flowing but with reversed polarity. Ha (7b)

Pipe Welding—Practical Field Testing and Instruction of Welders. D. O. Ferguson. *Heating Piping & Air Conditioning,* Vol. 7, July 1935, pages 335-337. Three classifications of welders made, B, A, AA. Each weld is stamped with the welders classification and his number. The classification card is held for 6 months and the best welders, AA or A receive the least attention in follow up tests. The beveling device for preparing pipe for welding by means of flame or arc cutting is discussed and the statement made that the thin black scale formed in this operation need not be removed for it does not affect the weld quality. WB (7b)

Some Recent Applications of Welding. A. F. Davis. *Journal American Welding Society,* Vol. 14, June 1935, pages 2-8. Discussion of various arc welded structures which are for the most part shown in photos. WB (7b)

Arc Welding Copper. A. F. Davis. *Sheet Metal Worker,* Vol. 26, July 1935, pages 311-312. Brief outline of proper procedure. Best results are obtained with welding at high speed, e.g. 20 in./min. on ¼" sheet with 600 amp. at 40 volts. The strength of such welds is 30-34,000 lbs./in.^{2} Ha (7b)

The Present Status of Fusion Welding of Aluminum and its Alloys (Ueber den gegenwärtigen Stand der Schmelzschweissung von Aluminium und seinen Legierungen). H. Bucholz. *Autogene Metallbearbeitung,* Vol. 28, July 15, 1935, pages 209-217. An exhaustive review of welding procedures for pure Al and Al alloys, properties of the welds, methods of hardening, with a great number of examples. In general, welding seams should be kept away from corners and edges to make them more accessible, and for sheets of more than 10 mm. thickness they should be arranged so that they are accesible from both sides. Ha (7b)

Welding in Relation to Automobile and General Repair Work. C. W. Brett. *Welding Journal,* Vol. 32, May 1935, pages 142-146. Article of practical, general nature. WB (7b)

Shaping of Welded Bodies (Formgebung geschweisster Körper). Joh. Braunfisch. *Die Elektroschweissung,* Vol. 6, July 1935, pages 121-127. Shaping of welded parts primarily depends on the commercial rolled products available. Efficiency depends on the possibility of using these products without too much preliminary work. Factors to be borne in mind are discussed in outlining the welding procedure applied to parts such as reinforcing flanges of flat and curved walls, levers, tension rods, casing of a bevel gear drive, and many others. GN (7b)

Pocket Book of Arc Welding (Taschenbuch für die Lichtbogenschweissung). Karl Meller. S. Hirzel Verlag, Leipzig, 1935. Cloth, 5¼ x 7¼ inches, 189 pages. Price 5 RM.

This pocket book, in German, known also as the "Small Meller" (Kleine Meller) is a condensed version of the more comprehensive volume "Electric Arc Welding" (Elektrische Lichtbogenschweissung) by the same author. It is written especially to meet the requirements of the ever-widening groups concerned with the process, embracing not only arc welders, foremen and engineers, but craftsmen and executives in many industries. All these wish to increase their knowledge of arc welding, so that they can recognize the causes of poor workmanship and failures and be able to avoid them, improve the quality and economy of arc welding, and develop new fields of application for the process. The pocket book should make it possible for the welder to understand the phenomena occurring during welding and apply the knowledge gained in improving and facilitating his work. Foremen will find the book of service in instructing and directing welders. It will assist them in inspecting the execution and quality of welded work. For engineers, the book contains practical hints, information on welding arrangements and fixtures and, in particular, factors governing the choice and criticism of electrodes. Executives, often relying on their own judgment in arc welding matters, should receive information and counsel from the book. Accordingly, the pocket book covers the most important subjects in the field of arc welding, laying particular stress on a generally understandable presentation. Due to the character and scope of the book a corresponding limitation or restriction of both the material and its presentation was necessary. Welding procedures, machines and equipment are discussed only so far as is requisite for their understanding and practical manipulation. On the other hand, electrodes are gone into more thoroughly, particularly as regards their welding characteristics, economy and effect on the welded joint. The most comprehensive section is the one dealing with steel welding, which process is continually becoming more important. After a short description of base metals, the fundamental forms of welded joints are shown. Practical welding is then discussed. Considerations such as the preparation and positioning of the work piece, the connection of the welding cable, the choice of current strength and electrode diameter, the question of penetration, arc length and form of bead, arc blow, the holding and guiding of the electrodes and the heat effect are taken up in turn. Then follow the sections on estimating the dimensions and costs of welded joints, cast iron and non-ferrous metal welding. As a conclusion, the test of welded joints, by non-destructive and destructive methods, and testing of welders is treated. E. V. David (7b)—B—

Cladding of Ferrous Products, A New Electrochemical Method. Raymond R. Rogers. *Industrial & Engineering Chemistry,* Vol. 27, July 1935, pages 783-789. 13 references. The demand for clad materials in order to increase the use of the more expensive metals and alloys is discussed. Cladding methods proposed by previous investigators are briefly summarized. A new electro-chemical method of cladding ferrous materials with (1) stainless materials, such as 18-8 Cr-Ni steel and low-C Cr irons, (2) high-C steel, (3) high-speed steel, (4) stellite; and (5) Ni is described. Photomicrographs showing excellent nature of the clad materials produced by the new method are included. The new method is summarized as follows: (1) Two plates of 18-8 are placed back to back with a thin separating layer of talc or magnesia in Na-silicate between them. These plates are welded together around the edges. (2) All nonmetallic material is removed from the exposed surfaces of the 18-8 plates. (3) Before a new nonmetallic film can be formed, a layer of Fe is electrodeposited upon the clean surfaces of the 18-8 plates. (4) A weld is produced between the 18-8 and the electrolytic Fe. (5) The composite thus produced is given a backing of ordinary, comparatively cheap, ferrous material by rolling (the electrolytic Fe being between the 18-8 and the backing material). MEH (7b)

Maintenance by Arc. C. M. Taylor. *Power,* Vol. 79, May 1935, pages 229-230. Maintenance of power plant equipment by arc welding is described. Costs are given. AHE (7b)

Experiments with Welding Wires for Build-up Welding (Versuche mit Schweissdrähten für Auftragschweissungen). K. L. Zeyen. *Autogene Metallbearbeitung,* Vol. 28, June 1, 1935, pages 161-169. Advantages of repairing by build-up welding are discussed; the hardness of the built-up material depends on the C content in the welding electrode and the kind of structure in which it occurs, and the structure is determined by cooling velocity of the weld. Experiments with gas and electric build-up welding are described to investigate the effect of the various factors, as type of flame, current density, and type of welding wire, on the hardness obtained, and also how hardness changes if several layers or only one are built-up. Results are shown in tables and photographs of structures· it is stated that with proper selection of the welding wire this method of welding is apt to find still wider application, and that it may be advantageous to provide even new pieces with a layer of very hard, built-up material at the place of greatest wear. Examples are given. Ha (7b)

Distortion Control Procedure. D. Boyd & G. Cape. *Welding Engineer,* Vol. 20, July 1935, pages 19-23. The distinction between plate stresses and weld stresses is pointed out and methods are described by which these stresses can be limited by proper application of heat and shaping of the joints. It is more advantageous to assemble large, complicated members from smaller welding units by a semi-flexible method of assembly. Best procedures are illustrated by examples. Ha (7b)

Progress of Electric Welding in Steel Industry. H. J. Bowles. *Iron & Steel Engineer,* Vol. 12, May 1935, pages 285-287. Describes methods of training welding personnel. WLC (7b)

Gas Fusion Welding in Artcraft (Gasschmelzschweissung im Kunsthandwerk). J. Blümmel. *Autogene Metallbearbeitung,* Vol. 28, July 15, 1935, pages 218-220. Application and examples of artistic effects are described. Ha (7b)

Welding on the All-American Canal Project. J. C. Coyle. *Welding Engineer,* Vol. 20, July 1935, pages 34-35. Work and equipment on this canal in Southern California is illustrated and described. Ha (7b)

Ship Welding and Classification Requirements. J. L. Adam. *Welder,* Vol. 7, May 1935, pages 553-558, 574. Materials used in ship building, methods of welding, testing and inspection are described and discussed as to their importance and application. Ha (7b)

Does Welding Code for Machinery Fill Industry's Needs? *Machine Design,* Vol. 7, June 1935, page 32. Critical discussion on the pros and cons of the tentative code for Fusion Welding and Flame Cutting in Machinery Construction recently issued by the American Welding Society. The proposed code calls for more stress relieving than is in use at present. Provision for radiographing welds with the same freedom from defects as required by the A.S.M.E. Loiler code is impractical in the case of fillet welds. Radiography in the A.S.M.E. code applies only to butt welds. WH (7b)

Electric Welding. *Commonwealth Engineer,* Vol. 22, Mar. 1, 1935, pages 233-234. Note on Australian developments in the fields of electric welding as applied to building industry, bridge construction, ship-building, boiler assembling, etc. WH (7b)

Recent Progress in Applications of Welding and in Welding Equipment (Derniers Progrès réalisés dans les Applications et le Materiel de Soudure Autogène). *La Technique Moderne,* Vol. 27, May 15, 1935, pages 345-347. Describes typical welded constructions and reviews progress in welding machines. FR (7b)

Electric Resistance Welding (La Soudure Electrique par Résistance). *Electricité (Science et Industrie),* Vol. 19, Apr. 1935, page 180. General article. FR (7b)

Generalities on Arc Welding (Généralités sur la Soudure à l'Arc). *Electricité (Science et Industrie),* Vol. 19, Apr. 1935, pages 177-179. General article dealing with electrodes used, automatic welding and applications of the process. FR (7b)

Welded Joints Studied with New Type Polariscope. *Engineering News-Record,* Vol. 113, Nov. 15, 1934, pages 621-622. New type of instrument has been developed in the photo-elastic laboratory of Columbia University. CBJ (7b)

Special Welding Method for Light Alloy Sheets (Procédé de soudure nervurée pour jointures de toles en alliages légers. Geripptes Schweissnahtverfahren für die Verbindung von Leichtmetallblechen). *L'Allégements dans les Transports,* Vol. 4, Jan./Feb. 1935, page 11. In French & German. Describes and fully illustrates a recently patented welding method specially designed for arc welding light metal alloy carriage bodies to insure simple erection and utmost rigidity. A special Al alloy containing 7% Mg is utilized for this purpose due to its favorable bending and welding properties. EF (7b)

How to Bronze-Weld. *Oxy-Acetylene Tips,* Vol. 14, June 1935, pages 125-131. Bronze-welding, as general term for actual bronze-welding and for bronze-surfacing, is used today for joining metals of high melting points, as cast Fe, steel, Ni, Cu and their alloys, by the use of a bronze bonding material. For use with the oxy-acetylene flame, a rod of 59% Cu, 40% Zn and 1% Sn is generally used, while recently other elements as Si, Mn, Fe have been added. Pb is objectionable as it increases porosity of the weld metal. The technique to be applied for different metals and fluxes to be used are described in detail. Ha (7b)

High-Pressure Boiler with Fusion-Welded Drums. *Engineering,* Vol. 139, May 24, 1935, pages 554-555. Brief illustrated article describing boiler recently installed by International Combustion, Limited, London. This is the first boiler with fusion-welded drums to be installed in England. The longitudinal and circumferential drum joints are of the double-welded butt type. In carrying out the welding process the Power Boiler Code of the American Society of Mechanical Engineers was followed. The joint efficiency produced was 90%. Tests consisted of tension tests on both the joint and the weld metal and a bend test transverse to the joint. A radiographic examination was made of all joints. LFM (7b)

Welding Practice and Technique. *Engineering,* Vol. 139, May 10, 1935, pages 505-506. Brief summary of papers presented in Group 2 of the Symposium on Welding of Iron and Steel held in London, May 2 and 3, 1935. This Symposium was organized by the Iron and Steel Institute in coöperation with other technical societies. LFM (7b)

Welding in the Engineering Industries—I. *Engineering,* Vol. 139, May 17, 1935, pages 529-530; May 24, 1935, page 558. Brief summary of papers presented in Group I, Sub-group (a) of the Symposium on the Welding of Iron and Steel, held in London May 2 and 3, 1935. The Symposium was organized by the Iron and Steel Institute in coöperation with other technical societies. LFM (7b)

The Welding of Iron and Steel. *Engineering,* Vol. 139, May 24, 1935, pages 550-553; May 31, 1935, pages 577-579; June 7, 1935, pages 606-607. Summary of the discussions of the papers presented before the Symposium on the Welding of Iron and Steel organized by the Iron and Steel Institute in coöperation with other technical societies and held in London, May 1935. IFM (7b)

Specification, Inspection, Testing and Safety Aspects of Welding. *Engineering,* Vol. 139, June 21, 1935. page 662. Brief summary of papers presented in Group 4 of the Symposium on the Welding of Iron and Steel, organized by the Iron & Steel Institute in coöperation with other technical societies and held in London, May 2 and 3, 1935. LFM (7b)

7c. Riveting

Rivets and Riveting in Theory and Practice. *Journal of Commerce, Shipbuilding & Engineering Edition,* May 30, 1935, pages 1, 3. A discussion on the relative advantages and disadvantages in the use of iron or steel for rivets, as regards burning, corrosion, and cracking, results in the conclusion that steel rivets are in every way superior. Suggestions are also made for the periodical testing of rivets before use. JWD (7c)

8. FINISHING

H. S. RAWDON, SECTION EDITOR

Surface Finish of Stainless Steels. Pickling, Grinding, Polishing, Browning, Etching (Oberflächentechnik bei nichtrostenden Stählen. Beizen, Schleifen, Polieren, Brünieren, Ätzen). *Metallwaren Industrie & Galvano Technik,* Vol. 33, Jan. 15, 1935, pages 31-32. There are many patented pickling solutions on the market. The following are widely used: (1) 50 HCl, 50 H_2O, 5 HNO_3 and 2 inhibitor, T = 60-70°C., time = 10-15 min.; (2) 15-20% H_2SO_4 at 60-70°C.; (3) 25 HNO_3 + 1 HCl, 73 H_2O + 1 inhibitor. Grinding and polishing should remove all scale. Abundant water supply, low grinding speeds, low pressure and Al_2O_3 wheels with ceramic binder are recommended. Polishing is done on felt wheels or leather-covered wooden discs with corundum and emery powder. Addition of talcum or fat counteracts burning. Mirror finish is secured on linen wheels with Cr-oxide which is superior to rouge for stainless steel. Dusty rooms should be avoided. 10% oxalic acid is used for browning. A further dip in 1% Na-sulphide solution produces black. 5% $KMnO_4$ solutions are particularly suited for browning. Etching should be avoided if possible. It is, however, preferable to stamping. After cleaning with benzene or turpentine, a protective coating of 4 pts. wax + 2 pts. colophony + 1 pt. pitch + 4 pts. asphaltum is applied as a "resist" in etching. A solution of 800 $FeCl_2$(40°Bé) and 300 cc. conc. HCl is very effective on 18/8. Light etching is accomplished with a saturated solution of $FeCl_2$ in HCl + few drops of HNO_3. Knife blades are etched at room temperature in 25-40% H_2SO_4 solutions. The protective coating can be removed with boiling water or tri-chlorethylene. EF (8)

Improved Finishes for Die Castings. JOSEPH FOX. *Steel,* Vol. 96, June 3, 1935, pages 34-36, 38. Deals particularly with Zn and Al alloys. Practically every type of commercial finish can be applied to die castings. Sales appeal is an important factor in choice of finish. Cr is most popular electroplated finish applied to Zn. Ni or Ni and Cu are first deposited on basis metal. For severe conditions, Cu plate direct on Zn has minimum thickness of 0.0004" and is followed by 0.0005"-0.0006" Ni and 0.000025" Cr. For good results the surface of the casting must be sound, polished and buffed properly, and cleaned thoroughly. Plating conditions must be controlled accurately. In application of enamels, lacquers, and similar coatings, the metal must be cleaned thoroughly, surface must be roughened or etched, and suitable priming coat used. Chromate and Fe_2O_3 and Al pigment in synthetic resin vehicles make good primers. Enamels made with newer synthetic resin of glyptal or bakelite type are being applied extensively to Zn castings. For low-cost finish, Zn is colored by immersion in chemical solutions. Many Al die castings are finished by polishing to a high luster. Other finishes for Al are a satin finish produced by scratch brushing, white frosted finish produced by dipping in strong alkaline solution followed by a dip in a strong mixture of HF and HNO_3; and a bright finish produced by ball burnishing. Although it is practicable to electroplate Al castings, this is seldom done. Japan is used extensively on Al. One of the best means of treating Al castings is by anodic oxidation. MS (8)

Finishing Plays Important Part in Manufacture of Office Equipment. F. L. PRENTISS. *Iron Age,* Vol. 135, June 20, 1935, pages 22-25. Describes various finishes and methods of application used by the Addressograph-Multigraph Corpn., Cleveland. VSP (8)

8a. Pickling

Sulphuric Acid from Spent Pickling Liquor. S. F. SPANGLER. *Heat Treating & Forging,* Vol. 21, May 1935, pages 238-240. **Reconditioning Pickling Solutions.** *Iron Age,* Vol. 135, Apr. 11, 1935, pages 11, 64-66. **Makes Sulphuric Acid from Spent Pickling Liquor.** *Steel,* Vol. 96, Apr. 15, 1935, pages 57-58. *Blast Furnace & Steel Plant,* Vol. 23, May 1935, pages 319-321. See *Metals & Alloys,* Vol. 6, June 1935, page MA 235L/3. MS + VSP (8a)

The Bullard-Dunn Electrochemical Metal Descaling Process. COLIN G. FINK. & T. H. WILBER. *Transactions Electrochemical Society,* Vol. 66, 1934, pages 381-392. The development and the underlying principles of the electrochemical descaling process for steel and other metals are discussed. Metal to be descaled is made cathode in hot acid sulphate bath containing a small amount of metal salt such as tin sulphate. A protective film of Sn or other metal is formed on areas as they are cleaned and pitting, etching, smudge formation and permanent embrittlement common in ordinary acid or electro-pickling, are prevented. The use of Si alloy anodes retards the oxidation of ferrous ions in the electrolyte and assures a long life of the electrolyte. The objectionable, frequent renewal of electrolyte required by the older processes is thus eliminated. (8a)

The Bullard-Dunn Process for Descaling Metals. *Machinery,* London, Vol. 46, July 4, 1935, pages 426-427. Description of process and the utility in descaling various types of scale. WB (8a)

Pickling of Soft Steel Sheets in Galvanizing Shops (Die Beizung weicher Stahlbleche in der Verzinkerei). *Metallwaren Industrie & Galvano Technik,* Vol. 33, Dec. 31, 1934, page 11. Mainly refers to recent experiments of EDWARDS (*Heat Treating & Forging,* Vol. 20, 1934, pages 393-399.) on the efficiency of H_2SO_4 pickling baths in relation to heat treatment of steels, their chemical composition, bath concentration, temperature, pickling time, concentration of Fe-salts in bath and agitation of the latter. EF (8a)

Inhibitors. K. B. LEWIS. *Wire & Wire Products,* Vol. 10, June 1935, pages 236-237, 243. Present inhibitors are reviewed and their effect on the pickled material shown in curves. Most inhibitors are organic substances but there are some essentially inorganic inhibitors in use. The real cause of the inhibiting action is not yet fully understood. Ha (8a)

8b. Cleaning, including Sand Blasting

Spray System Facilitates Descaling of Steel. *Steel,* Vol. 96, June 24, 1935, pages 43-46. **Descaling of Steel.** *Blast Furnace & Steel Plant,* Vol. 23, Aug. 1935, pages 541-545. Describes system used in continuous wide strip mill, which is also applicable in rod mills and other mills where high finishes are desired. Involves strainer, pump, accumulator, distributing lines, spray valves, and nozzles. H_2O pressure ranges from 800 to 1300 lbs./in.^{2} At 1000 lbs. pressure, H_2O velocity is about 4 miles per min. MS (8b)

Use of Inhibitors in Cleaning Metallic Pipe. A. ABRAMS & C. L. WAGNER. *Water Works & Sewerage,* Vol. 82, May 1935, page 192. Water pipes clogged by corrosion or deposits from the water can be cleaned by using acid solutions to which an inhibitor consisting of a small quantity of nitrogenous materials, such as aniline or pyridine, is added. This mixture will attack rust or scale but practically has no action on the metal itself. HCl containing about 3% by volume of the inhibitor was used satisfactorily to clean pipes installed behind walls in a large building. The cost of this treatment was considerably less than that of replacement of the pipes. Ha (8b)

8c. Polishing & Grinding

Copper and Abrasives. H. L. WYNN. *American Machinist,* Vol. 79, May 22, 1935, page 403. Powdered glass is particularly suitable as abrasive for Cu as the particles are not imbedded in the material and thus maintain a grinding action after the powder has been wiped off as is the case with the generally used artificial abrasives. Powdered glass gives best results when mixed with ordinary lubricating oil and can be used in all kinds of lapping. Ha (8c)

Polishable Cadmium Deposits (Polierbare Kadmiumüberzüge). F. SCHWARZ. *Oberflächentechnik,* Vol. 12, Apr. 2, 1935, page 82. Cd deposits which are usually so soft that they will not stand the normal polishing processes without destruction can be made harder and polishable by addition of zinc-potassium cyanide to the bath; Zn will gradually be deposited with Cd as alloy and thus harden the deposit considerably. Such Cd-Zn deposits also give a better rust protection than either pure Cd or Zn. An alloy of 85% Cd and 15% Zn which has the same color as Cd can be deposited from a bath containing Zn and Cd in about equal amounts, with current densities of 2-4 amp./dm.^{2} Throwing power and current yield of the bath, are not deteriorated by Zn addition. The deposits are very bright even without addition of organic colloids. A suitable polishing agent is composed of 12 parts French chalk, 2 parts tallow, 2 parts stearine, 1 part montan wax, 1 part mineral oil. Tripoli should not be contained in the polish. Ha (8c)

8d. Electroplating

Anodic Behavior of Tin During Electrolysis in Sodium Stannate Solution (Das anodische Verhalten des Zinns bei der Elektrolyse in Natriumstannat-Lösung). GÜNTHER HÄNSEL. *Zeitschrift für Elektrochemie,* Vol. 41, June 1935, pages 314-321. Electrodeposition of Sn in dense form from Sn stannate solutions was investigated with particular attention given to the valence with which the Sn is dissolved from the anode. Previous tests by author and others showed that when Sn dissolves from the anode in bivalent state to form stannite, the electrodeposit is spongy, loose and non-adherent. It was therefore necessary to keep the electrolyte free from bivalent Sn. 2 methods are discussed: (1) by a suitable oxidizing agent in the electrolyte to convert the bivalent Sn completely to the stannate, (2) by a suitable polarization of the Sn anode to produce tetravalent Sn directly. The first method was ruled out because the literature shows that even with excess Na_2O_2, H_2O_2 or ozonized air in the solution there is always considerable stannite present since the oxidizing action is slow. Method (2) was investigated by means of potential-current density curves for various Sn and NaOH contents of the electrolyte, by keeping Sn constant and varying NaOH and vice versa, and also potential-current density curves at various temperatures. The inflection point on the curves shows the current density at which the anode becomes passive, is covered with a thin film of Sn oxide and the Sn dissolves from the anode entirely in the tetravalent condition. A larger scale continuous test was carried out under conditions which previous work had shown to be optimum. The cell contained 7 l. of solution with Sn contents of 11.3, 13.2 and 7.5 g./l. Sn as stannate, 5-6 g./l. NaOH which was kept constant throughout the test of 189 hours. The anode and cathode current density was the same, (150 amp./m.^{2} with 7 amp. through the cell at 70° C.) and the solution not agitated. The distance between anode and cathode was 4.5 cm. The Sn deposit was dense and silver-white in color, the cathode efficiency, 72.8% and anode efficiency, 76.2%. The anode gassed slightly, O_2 being evolved and the yellow passive film on the anode was maintained throughout the electrolysis. If the NaOH was allowed to go lower than 3 g./l. stannic acid formed at the anode and affected the current efficiency adversely. By using the relatively high temperature of 70° C. the current efficiency was increased, at 40-45° C. it averaged only 25%. The patent covering the process recommends the use of Elektron sheet (Mg alloy) for cathode from which the Sn may be stripped in any desired thickness or from which starting sheets of electrodeposited Sn may be taken. HAS + WB (8d)

Electrolytic Tinning (Über die elektrolytische Verzinnung). MAX SCHLÖTTER. *Metallwirtschaft,* Vol. 14, Mar. 29, 1935, pages 247-250. Sulpho-acid plating solutions of Sn (composition not given) have the following advantages over alkaline solutions: A temperature of 15°-25° C. can be used instead of about 75°, the best current densities are 200-300 amps./m.^{2} compared with 50-75, the current efficiency is 99% instead of 65-75%, and the voltage required is only 1.5-2 compared with 3-4 for alkaline solutions. Current densities up to 1500 amps./m.^{2} can be used. Recently a process has been developed for obtaining glossy Sn deposits by producing small grain size. The problem of speed has been solved by the development of a plating machine which can Sn plate wire at the rate of 120 m./min. with a thickness of 10-20 g./m.^{2} The cost of Sn plating is less than that of hot tinning, on account of the high oxidation losses in hot tinning. In an extensive test of hot tinned and Sn plated wire made by a large cable company, the plated wire met all test requirements and had more advantages than disadvantages. Since a pure Sn coating is formed with no alloying as in hot dipping, plated wire is softer and more ductile and sheets have better deep-drawing properties. Sn plated sheets are used successfully for tin cans, providing the sheets have a smooth, dense surface before plating. If they are rough or pitted it is necessary to hot tin them. CEM (8d)

On the Electrolytic Growth of Metal Crystals. I. Growth of Silver Crystals from Aqueous Solutions (Über das elektrolytische Wachstum der Metallkristalle. I. Wachstum von Silberkristallen aus wässerigen Lösungen). T. ERDEY-GRÚZ. *Zeitschrift für physikalische Chemie,* Abt. A, Vol. 172, Feb. 1935, pages 157-187. Ball-shaped cast cathodes of a single crystal of Ag grow electrolytically in most aqueous solutions of complex salts and maintain the original lattice orientation with formation of smooth external planes. The lattice planes of predominant growth depend uniquely on the chemical species in solution independently of their concentration and of current density within the orders of magnitude from 10^{-5} to 10^{-4} amps./cm.^{2}. Measurements of the cathode potential as depending on current density indicate that the rate of growth is determined as follows: in solutions of $AgI + KI$ and $Ag_2O + H_3N$ by the rate of two dimensional nucleus formation, in solutions of $AgBr + H_3N$ and $AgCl + H_3N$ by the rate of ion discharge, and in solutions of $AgBr + KBr$, $AgBr + H_4NBr$, $AgCl + H_4NCl$, and $AgCN + KCN$ by the rate of ion delivery to the growing planes. Observed deviations of predominant growth from postulates of the Kossel-Stransky theory are attributed to a selective adsorption of molecules and ions present in the solution. In solutions of simple Ag salts the electrolytic growth is irregular. ORS (8d)

Testing Methods for Chromium Electrolytes (Ueber Prüfmethoden von Chromelektrolyten). HÜTTER. *Werkstoffe & Korrosion,* Vol. 10, Apr. 25, 1935, pages 17-20. Cr electrolytes may be tested in 2 ways: chemical-analytical control and physical or physical-chemical tests respectively. The latter contains the practically important determinations of volt and ampere curve, amount of deposit, throwing power, pH, structure of deposit, and mechanical properties of deposit. The manner of testing these different quantities is described and reviewed. Ha (8d)

Evaluation of the Protective Power and Thickness of Electrolytic Deposits (Die Ermittlung des Schutzwertes und der Stärke galvanischer Niederschläge). JOACHIM KORPIUM. *Metallwaren-Industrie & Galvano-Technik,* Vol. 32, Aug. 15, 1934, pages 364-368. Service tests are best, but require too much time. Salt spray tests (20% NaCl + 5% $MgCl_2$) at 25° C. of 2 days duration are stated to correspond to one year atmospheric corrosion and are suited for Ni, Cr, Cd, Sn, Zn, Pb, Ag and Au coatings. Porosity and lack of corrosion resistance are closely connected. A solution for testing porosity of the above metal coatings on Fe, Cu or Cu alloys consists of 100 cc. H_2O, 7.5 g. gelatine, 3 cc. glycerine and 1.0 g. K-ferricyanide. Blue spots appearing after 20-30 min. indicate pores. For brass, 5 g. NH_4Cl should be added. Filter paper soaked in a solution of 60 g. NaCl and 10 g. K-ferricyanide/liter H_2O is also suitable. The porosity of Cr coatings on Ni is checked by a solution of 20 g. NH_4Cl, 0.5 cc. NH_3 and 10 cc. of an alcoholic solution of dimethyl glyoxime in 100 cc. H_2O. An electrolytic test utilizes 200 g. $CuSO_4$ in 75 g. H_2SO_4/l. (0.2 volts, 5 min.). The porosity test on galvanic coatings on Al is based on the gas liberation in gelatine solution containing 2.5% caustic soda (room temperature). For coatings on Zn, a sugar solution with 5% glycerine, and 30% NaOH is used at 80° C. A simple and effective porosity test for Cr and Ni plating on Zn and its alloys is a 5-10 min. dip into a solution of 200 g. $CuSO_4$ and 20 g. H_2SO_4/l. H_2O. Ni coatings with more than 4 pores/cm.^{2} are unsuitable for outdoor service. The usefulness of Ni-platings can also be evaluated by thickness measurements since the number of pores decreases with increasing coat thicknesses. The latter can be estimated with the aid of an included table referring to Ni, Cu, Cd, Sn, Zn, Pb, Ag, brass and Cr coatings. Outlines 13 methods of dissolving these coatings on the most commonly used carriers with the object of determining the thickness of the deposit. EF (8d)

Observations on the Effect of Mechanical Agitation on Electrode Potential. F. O. KOENIG. *Journal of Physical Chemistry,* Vol. 39, Apr. 1935, pages 455-463. The electrokinetic theory of the effect of mechanical agitation (moving of electrode or electrolyte without scraping of electrode surface) upon electrode potential is critically discussed. It is pointed out that this theory is only one possible explanation, an alternative being the theory that irreversible chemical processes are partly or wholly responsible for the effect. Experiments with Ag electrodes in KCl solutions saturated with AgCl and in $AgNO_3$ solutions are described which lend support to the chemical theory of the effect. EF (8d)

Rubber in the Plating Industry. R. H. KITTNER. *Monthly Review American Electro-Platers' Society,* Vol. 21, Oct. 1934, pages 17-25. Hard rubber is more resistant to acids and alkalis because of high (up to 47%) S content. Pigments such as inorganic oxides and silicates raise temperature resistance of rubber from 120° to 150° F. Rubber linings for steel tanks are discussed. GBH (8d)

Electrolytic Production of Nickel Type Matrixes. (Die elektrolytische Herstellung von Nickelmatern). A. WOGRINZ. *Metallwaren Industrie & Galvano Technik,* Vol. 32, Nov. 15, 1934, pages 497-498. Method for the electrolytic production of molds for type-casting machines is illustrated. Ni molds which have replaced Cu ones, have greater resistance against molten Pb-Sb alloys. Special electrolytic conditions are required for making the molds, a current of only 0.6 amps. being used. The electro-deposition takes over a week. The most suitable electrolyte, current, temperature and concentration control are dealt with. EF (8d)

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The Anodic Coating of Aluminum. HAROLD K. WORK. *Metal Industry,* N. Y., Vol. 33, May 1935, pages 168-170. Contains bibliography. From Monthly Review of the American Electro-Platers Society, April 1935. The article to be treated is made the anode and oxygen is deposited to form aluminum-oxide. A 3% chromic acid electrolyte forms a gray corrosion-resistant oxide. The voltage required is 40 to 50 volts. Another electrolyte requiring high voltage is oxalic acid. A widely used electrolyte is H_2SO_4. Hard white coatings are produced. Exhaust systems to remove fumes are required. The racks must make close contacts with the article being coated. Anodic coating solutions, as a rule, have very good throwing power. Outstanding characteristic of anodic oxide coating is high abrasion resistance. The coatings are absorptive. Treatment with boiling water will effectively seal the coating and prevent them from becoming stained or from absorbing dyes. The corrosion resistance of the coatings may be improved by absorbing substances such as silicates and chromates in them. The oxide coating, when dry, is an excellent electrical insulator. Commercial applications are briefly discussed. PRK (8d)

Dropping Tests for Determining the Local Thickness of Electrodeposited Zinc and Cadmium Coatings. R. O. HULL & P. W. C. STRAUSSER. *Monthly Review, American Electroplaters' Society,* Vol. 22, Mar. 1935, pages 9-14; *Metal Industry,* N. Y., Vol. 33, Apr. 1935, pages 133-134. A solution of acidified ammonium nitrate is allowed to fall from a glass tip at the rate of 80-100 drops per minute on the coating to be tested. The time required for the coating to be dissolved is noted. Each second is equivalent to .00001″ thickness. If fresh solution is supplied continuously this method is more accurate for determining minimum thickness than immersion methods such as the Preece test. For Cd the solution is 110 g./l. C.P. ammonium nitrate and 10 ml./l. conc. HCl (sp. gr. 1.18) For Zn; 100 g./l. ammonium nitrate and 55 ml./l. of conc. HNO_3 is required to obtain the rate of .00001″ per second. GBH + PRK (8d)

Silver Plate to Specifications. C. B. F. YOUNG & S. C. TAORMINA. *Metal Industry,* N. Y., Vol. 33, May 1935, pages 165-167. Conditions necessary to produce a specified thickness of Ag deposit in commercial operations were studied. In one test the cathode efficiency of the pilot was very close to 100% and the average efficiency of single pieces 79.5%. In another test, the average efficiency for pilots was 93.3%, while the individual pieces averaged 73.1%. Current density up to 3 amperes and time are stated to have little effect on the efficiency of the tank. A ratio between the efficiency of the pilot and of all the work of identical pieces in the tank was established as 99 to 96. In a tank load of pieces of dissimilar shape and size, the highest efficiency was 165% and lowest, 71%. With respect to average current density, some hollow items showed high efficiency while objects of large area were low in efficiency. Test showed that the % Ag buffed off is 15 maximum, 5.5 minimum and 10.6 average. In order to plate Ag to specifications it is necessary to have a balanced solution, even distribution of work with respect to anodes, articles of similar shape and size in tank at the same time, actual areas need not be taken for computing current density but a pilot may be used instead. Thorough cleanliness of all electrical connections at all times is of prime importance. PRK (8d)

8e. Metallic Coatings other than Electroplating

Investigations of the Process of Galvanizing Iron. III. Determination of the Relation between Temperature and Solubility of Nickel, Chromium and Manganese Steels in Molten Zinc (Untersuchungen über die Vorgänge beim Verzinken von Eisen. III. Bestimmung der Temperaturabhängigkeit Löslichkeit von Nickelstählen, Chromstählen und Manganstählen in geschmolzenem Zink). Heribert Grubitsch. *Monatshefte für Chemie,* Vol. 65, Dec. 1934, pages 122-128; *Sitzungsberichte der Akademie der Wissenschaften in Wien, Mathematisch-naturwissenschaftliche Klasse,* Abt. II B, Chemie, Vol. 143, No. 9, 1934, pages 474-480. The steels investigated were No. 9, .10 C, 3.62 Ni; No. 10, .07 C, 5.03 Ni; No. 12, .45 C, 25.38 Ni; No. 5, .03 C, 4.09 Cr; No. 6, .06 C, 9.87 Cr; No. 1, .05 C, 2.65 Mn; No. 2, .60 C, 1.67 Mn; No. 3, .15 C, 11.65 Mn. Small discs of the steels were ground and after preliminary galvanizing were weighed and placed in molten Zn at various temperatures for 1 hour. The loss in wt. of the discs and the % Fe in the Zn were then determined. In the case of the Ni steels the Fe in the Zn decreased with increasing temperature from 440° C. to a maximum at 460°-480°, then rose, with maxima at 500° for No. 9 and 10, dropped and rose again. No. 12 rose consistently after the first maximum. The solubility of Cr steels was similar to that of plain C steels. It reached a maximum at 490°-510° which was less pronounced than that of the Ni steels. No. 2 and 3 steels had curves with flat maxima and the solubility of No. 3 was quite high at low temperatures. No. 1 had no maximum, its solubility increased steadily with rise in temperature. Its solubility was not affected by pre-heat treatment nor by the length of time in the Zn. Photomicrographs to confirm the solubility test results are given. On No. 1 Mn steel a compact alloy layer was formed which protected the Fe against attack from the Zn. No new metallographic structures were found. The highly alloyed steels, especially No. 6, were difficult to galvanize. EF + CEM (8e)

Characteristics of Sprayed Metal. W. E. Ballard. *Mechanical World & Engineering Record,* Vol. 97, Feb. 1, 1935, pages 103-104. Abstract of a paper presented to the Manchester Association of Engineers. See "Protective Metallic Coatings by the Wire-Spraying Process," *Metals & Alloys,* Vol. 6, Apr. 1935, page MA 156. Kz (8e)

Protection of Concrete Against Acids (Säureschutz des Betons). C. H. Daeschle. *Bautenschutz,* Vol. 6, Feb. 1935, pages 22-23. Deals with the Pb coating of concrete by means of the metal-spraying process to ensure water tightness and resistance against corrosion. Kz (8e)

Submersion Time Versus Quality of Hot-Dip Zinc Coatings. Wallace G. Imhoff. *Iron Age,* Vol. 135, June 6, 1935, pages 16-17, 124, 126, 128. Experimental data show that characteristics of Zn coatings are definitely affected in the following respects by change of submersion time, other factors being constant: (1) Spangle or crystallization effect; (2) Finish of non-spangled coatings; (3) Thickness of coating; (4) Fe content of coating; (5) Weight of coating; (6) Bending qualities of coating; (7) Smoothness of coating (8) Luster of coating; and (9) Adherence of coating to basis metal. The shorter the submersion time, the smaller the spangles and the longer the submersion, the larger the spangles. Too long submersion may obliterate the spangle. Non-spangled coatings left too long in bath become rough. Fe content of bath makes Zn coating brittle. Steel galvanized in bath of new Zn possessed superior bending qualities. Includes tabular data on bending tests of galvanized coatings on one-pass cold rolled steel. VSP (8e)

8f. Non-Metallic Coatings

Ships' Paints and Compositions. *Paint, Colour, Oil, Varnish, Ink, Lacquer Manufacture,* Vol. 4, Dec. 1934, pages 363-366. The practice is to allow rust to form while the ship is on the ways so that it can be easily chipped or scraped off immediately before painting. Red lead has proved over many years' actual experience to be best primer. Bitumen, graphite and Fe oxides have been tried. A black lead suboxide paint has recently been claiming attention. Plenty of time allowed for the primer to harden. Red lead rapidly decomposes in presence of sea-water to form lead chloride and caustic soda according to $Pb_3O_4 + NaCl = 3\ PbCl_2 + 3\ Na_2O + O$ and once the protective top coat goes the red lead primer follows very rapidly. The Pb-chloride combines with Fe to form Fe-chloride and metallic Pb which constitute a strong galvanic couple which accelerates further corrosion. Considering red lead as anti-rusting and anti-corrosive finish is a fallacy. An enormous future is seen for phenol-formaldehyde type of synthetic resin paint mediums (typical mixture: 10 lb. tung oil, 2.5 lb. Bakelite XR 254, 25 lb. white spirit, 25 lb. turpentine and trace of cobalt dryer), because they possess adherence, elasticity and durability. Al-metal paints are excellent in many cases. Most ship paints corrode first at the rivets for which several explanations are given. Often a Zn-plate bolted in a boiler acts satisfactorily for corrosion protection. Under-water paints, anti-foulings and poisons are discussed at length. EF (8f)

Crystal Japan Finish on Metal. C. F. Scribner. *Industrial Finishing,* Vol. 10, Feb. 1934, pages 26, 28, 30. A single coat of crystal japan applied directly to the metal imparts a smooth appearance to rough surfaces without preliminary filler or hand-sanding. The finish is hardened by baking. Fine or large crystals can be obtained by varying the thickness of the coat applied. Dull black is the most popular color, although a transparent form and several bright colors are available. JN (8f)

Steel Office Furniture. Fred A. Schmitz. *Industrial Finishing,* Vol. 10, June 1934, pages 36, 40, 42. Brief description of the application on steel office equipment of baked enamels of standard colors and imitation wood finishes with wood graining effects. JN (8f)

A Study of Certain Factors Affecting the Proper Firing of Porcelain Enamel on Steel or Iron. H. E. Ebricht & G. H. McIntyre. *Industrial Heating,* Vol. 2, June 1935, pages 293-298. Porcelain enamels are silicate glasses fused to a steel or Fe base at 1200°-1700° F. Tests are described which revealed the great importance of furnace atmospheric condition, and temperature in avoiding defects like scumming, blistering and copperheading. These may be due to foreign gases in the furnace. Ha (8f)

Aluminum Paints (Aluminiumpulverfarben in der Anstrichtechnik) Freitag. *Oberflächentechnik,* Vol. 12, June 18, 1935, pages 152-153. A superior dense coat of Al paint is obtained if the Al powder and the binder are mixed immediately before the coat is applied. An Al coat is particularly advantageous for protecting materials exposed to strong sunshine (tropics), or for protecting vessels, rooms, etc. against heat radiation (airships, railroad cars, storage tanks for combustible liquids). Ha (8f)

Bituminous Protective Coatings. R. Forder. *Paint, Colour, Oil, Varnish, Ink, Lacquer Manufacture,* Vol. 4, Oct. 1934, pages 299-302. Critical discussion of term "bitumen." There is no point in adding a pigment such as carbon black to bitumen solutions, but the addition of leafing pigments such as graphite, Al, etc. is advantageous. The effectiveness of the film is increased by forcing any permeating substance to travel a circuitous path. Coal tar solvents containing tar acids are useful for internal application to marine boilers and tubes. Addition of Al powder, which forms a surface layer, protects the bitumen from excessive heat and makes possible the use of a more elastic bitumen. Elasticity is important when the paint is to be used on iron work under tropical conditions. Red lead and some other primers, although equal to unprimed panels in still water, developed cracks in running water. Priming induced cracking on those metallic test panels which were exposed alternately to the atmosphere and water. It is the best practice to use a bitumen primer for work subject to running water. One of the greatest disadvantages of bitumen paints used to be that bright colors could not be obtained. Recent advances to remedy this are described. However, no data as to the performance of such paints under exposure are available. The chief advantage of bitumen lies in its neutral behavior and for this reason it is especially useful for marine work and in locations subject to acid and alkali. The results of accelerated weathering cabinet tests are stated to be almost of negligible practical value (for bitumen) as a means of evaluating its behavior in outside exposure. Recipes for colored bitumen, paints, bitumen emulsions and plastics are given. EF (8f)

Black, Brown and Gray Coloring of Aluminum (Schwarz-, Braun- und Graufärbeverfahren für Aluminium) H. Krause. *Aluminium,* Vol. 17, May 1935, pages 259-260. Immersion methods for coloring Al were studied and the following solutions are stated to give satisfactory results. A solution in one l. H_2O of 5-10 g. $KMnO_4$ with 2-4 cc. HNO_3 of 1.35 sp. gr. (38° Bè) and 20-25 g. copper nitrate is used for producing black, and 5 g. copper nitrate for brown. The solution is applied almost boiling at 80° C., the depth of color depending on the immersion period. Deep black required 20-30 min. A solution of 10-20 g. ammonium molybdate, 5-20 g. sodium acetate in 1 l. H_2O to which some ammonium chloride was added gave a deep black in about 1 min. The colored sample will stand bending without coming off. Boiling solutions of 100 g. diammonium phosphate and 5 g. manganese nitrate in 1 l. H_2O gave a matte gray surface of velvety gloss. Samples cleaned mechanically by scraping, brushing, sand-blasting, gave better results than samples pickled before immersion. A spotty appearance often resulted in the latter case. Ha (8f)

Progress in Enameling Technique (Ein Fortschritt in der Emailliertechnik). A. Karsten. *Die Metallbörse,* Vol. 25, Feb. 20, 1935, pages 225-226. Various reasons for decreasing commercial utilization of the enameling process are discussed. Recent investigations on thermal expansion are reviewed. (Bureau of Standards). A modified Schoop spray gun is now available which is suited for spraying and patching up enamel coatings. The internal stresses in sprayed enamel coatings are materially lower than in coatings made by the ordinary process and adhesion is considerably better. EF (8f)

The New Streamlined Train's Decorative Color Effects. Sterling B. McDonald. *Industrial Finishing,* Vol. 10, Mar. 1934, pages 13-14. A description of the interior and exterior color schemes and finishing procedures used on 3 Al alloy cars of streamline design for the Union Pacific System. JN (8f)

The Production of One Cover Coat Enamel Finishes on Sheet Steel. F. R. Porter. *Enamelist,* Vol. 12, June 1935, pages 5-7. Requirements for obtaining a good coat of enamel in one coating over the ground coat on sheet steel are discussed. Correct materials, correct processes and well organized and trained enamel shop personnel must be employed. Ha (8f)

Mechanically Wrapped and Coated Pipe Helps Fight Against Corrosion. Andrew M. Rowley. *Oil & Gas Journal,* Vol. 33, Feb. 7, 1935, pages 30-31. Coating and wrapping pipe at the mills has been adopted by the large pipe companies. A special method of loading to ensure its transportation without damage is described. VVK (8f)

New Protective Coatings for the Protection of Structural Steel. B. Scheifele. *Paint & Varnish Production Manager,* Vol. 12, June 1935, pages 14-15, 16-17. The use of synthetic resins in the varnish industry is increasing. They are used either alone or in combination with nitrocellulose oil-modified glyptal resins for varnishing large vehicles, railway coaches, buses, etc. These products offer new possibilities in undercoats and top coats for structural steel. Red lead retains its rustproofing potency in synthetic resin vehicles and in chlorinated rubber as well as in linseed oil. WHB (8f)

Reconditioning Plant for Pipe Line Companies. Neil Williams. *Oil & Gas Journal,* Vol. 33, Jan. 17, 1935, page 18. Description of the pipe reconditioning plant of the Houston Pipe Line Co. and the Johnson-Marsh Corp., a commercial plant for cleaning, conditioning and coating pipe. VVK (8f)

Coloring of Aluminum and Aluminum Alloys (Färben von Aluminium und Aluminiumlegierungen) H. Krause. *Metallwaren Industrie & Galvano Technik,* Vol. 33, Dec. 31, 1934, pages 8-11; Jan. 15, 1935, pages 29-31. See *Metals & Alloys,* Vol. 6, Apr. 1935, page MA 158R/6. EF (8f)

9. TESTING

9a. Inspection & Defects, including X-Ray Inspection

C. S. BARRETT, SECTION EDITOR

Studies of Flakes in Chrome-Nickel Steels by Spectrum Analysis (Spektralanalytische Untersuchungen an Flocken in Chrom-Nickel-Stählen). H. Esser, W. Eilender & A. Bungeroth. *Archiv für das Eisenhüttenwesen,* Vol. 8, Mar. 1935, pages 419-423. By means of X-ray and optical spectrum analysis of flaky Cr-Ni steels, it was shown that a thin layer at the surface of the flakes was higher in Cr, Ni, and Mn. On radiation of the surface of the flakes with X-rays, H gas was given off. The origin of the flakes was attributed either to embrittlement resulting from the segregation of hydrides or to the decomposition of the hydrides and resulting high H pressures. SE (9a)

Metal Examination by Means of Ultra-sonic Waves. L. L. Myasnikov. *Vestnik Metallopromishlennosti,* Vol. 15, Jan. 1935, pages 33-38. In Russian. Sound waves of high frequency, such as emitted by a vibrating quartz plate, freely pass through metals, particularly when the sound is represented by a sound beam. Such a beam is reflected or dispersed on sudden changes in acoustic hardness, as, for example, at the boundary line between the metal and air or at the discontinuities in the body of the metal. When a beam encounters such discontinuities on its passage through a metal, its vibrations are locally dampened producing an equivalent of shadows in the beam. They can be demonstrated by coating with oil the side of the object from which the beam emerges. Undampened beam produces on the surface of oil a multitude of minute ripples, which are absent where the beam is dampened. Such an examination is possible on quite heavy sections, more than one meter thick. (9a)

Flakes and Hairlines in Alloy Steels. I. Ignatov. *Vestnik Metallopromishlennosti,* Vol. 14, Dec. 1934, pages 116-129. In Russian. Large amount of plant work showed connection between flake formation and speed of cooling of ingots. Cooling at the rate of 2° C. per minute or less is recommended after every heat treatment to prevent their formation. The amount of flakes increases with the cross section of the rolled article. Heat treating even at high temperaures is powerless to eliminate flakes without mechanical working. A method used at the plant for location of the flakes is described. (9a)

Inspection Methods of Phosphate Products Used for the Protection of Iron, Cast Iron and Steel (Metodi di Controllo dei Prodotti fosfatici usati per la Protezione del Ferro, Ghisa, Acciaic). O. Macchia. *Industria Meccanica,* Vol. 17, June 1935, pages 515-517. Methods used to determine humidity, efficacy, and amount (in g./m.^{2}) used on the surface of phosphate films produced as rust protective measures in recent years are described together with the apparatus for the process. Ha (9a)

Surface Examination in the Foundry (Oberflächenuntersuchungen in der Giesserei). G. Stade. *Giesserei,* Vol. 22, July 5, 1935, pages 339-340. Describes a specially constructed microscope with which comparative surface examinations of plane, concave and convex surfaces can be made as routine determinations in the shop. Ha (9a)

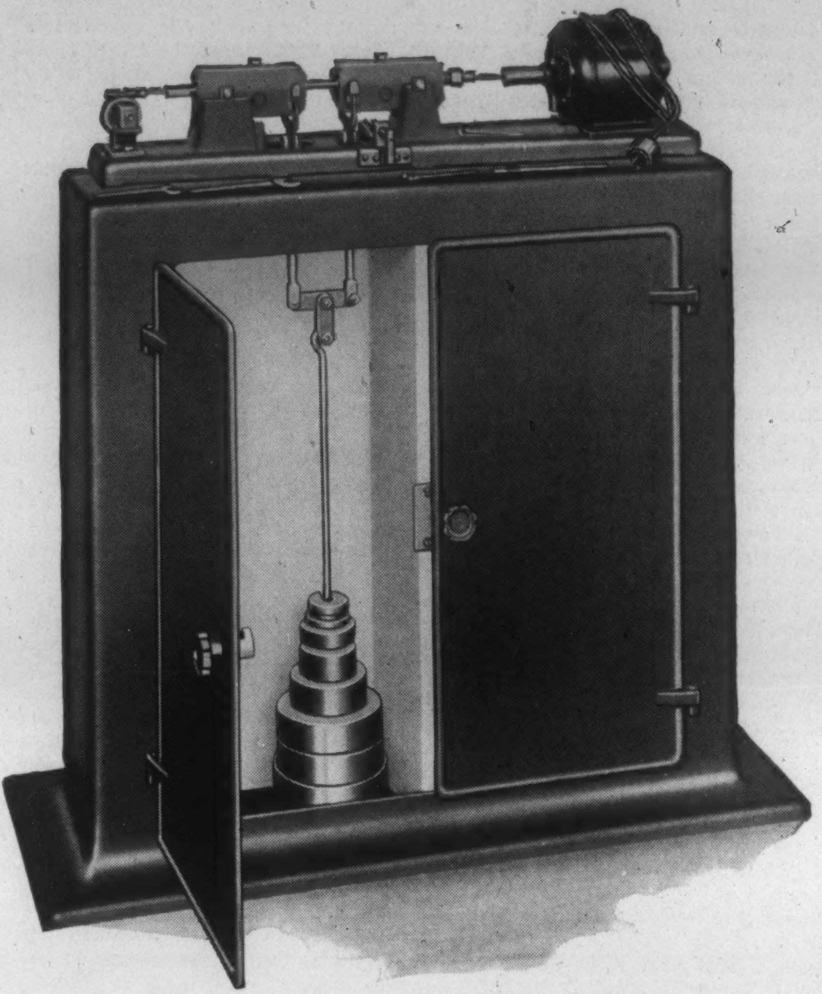
Inspection of Welds, with Particular Reference to Radiography. H. R. Isenburger. *Welding Engineer,* Vol. 20, June 1935, pages 26-27. Necessity for radiography for detecting unsound welds is pointed out, apparatus and procedure are described. Ha (9a)

9b. Physical & Mechanical Testing

W. A. TUCKER, SECTION EDITOR

Notch Brittleness in Large Bars. *Engineering,* Vol. 139, Mar. 15, 1935, pages 285-286. Experience has indicated that large steel castings and forgings exposed to bending are liable to fracture in brittle manner that seems inconsistent with results of tests on standard smaller sections, as happens to be the case with stem castings or forgings of vessels receiving injuries in collision. Difference observed between more brittle type of fracture of large notched piece, and tougher form of fracture of smaller but otherwise similar piece of some material, does not so far appear to have found any scientific explanation. It is attributed to fatigue or other causes, or simply to flaws in larger pieces, and effect of size is disregarded. Cites opinions of various investigators. One of the conclusions drawn is that different steels might be arranged in sequence of notch-brittleness, as judged, not merely by the number of ft.-lbs. required to break a standard Izod test piece, but of the size of test piece at which transition occurs from more ductile to more brittle type of failure. Some investigators claim that transition from ductile to brittle type of notched-bar fracture depends on temperature and sharpness of notch and ratio between breadth and depth of test piece. Recommends welded bows for vessels. VSP (9b)

Slow Bending Tests on Large Notched Bars. J. G. Docherty. *Engineering,* Vol. 139, Feb. 22, 1935, pages 211-213. Object of test was to investigate the variation, with size, of point at which initially smooth progress of test might be interrupted by a sudden crack as well as by a change in character of fracture, from moderately ductile type with considerable deformation, to brittle type with practically no deformation. Gives several graphs showing the results of tests. Stress at which tearing commences is practically constant, irrespective of the size of the specimen. Load increased steadily with increase of deflection up to a maximum. Cites tests conducted by other investigators. VSP (9b)



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PRESSURE BLOCKS VIBROGRAPHS TORSIOGRAPHS

A General Elasticity Law for Brittle Materials (Über ein allgemeines Elastizitätsgesetz spröder Körper). H. Schlechtweg. *Zeitschrift für angewandte Mathematik und Mechanik,* Vol. 14, Feb. 1934, pages 1-12. Considers brittle materials such as cast Fe, sand stone, etc., when submitted to tensile stresses at pulling speeds generally applied in testing materials. The object of the mathematical derivations and practical experiments (cast Fe tubes submitted to pure tensile, pure torsional and combined tensile-torsion stresses) was to establish a law covering the virginal mechanical behavior of brittle materials with reference to strain states. The definition and characteristic properties of elastic bodies according to Hooke, of plastic and brittle materials is considered at length. Micro-structures of cast Fe are presented showing the inhomogeneity of this material in which homogeneous stress states can hardly exist. The mathematical approach to this problem with the aid of invariants of the stress tensor and the practical tests yielded deviations between stress tensor and deformation tensor largely depending on the mean tensile stress. In addition to modulus of elasticity and coefficient of reduction of area, 3 new material coefficients are introduced. The latter characterize more or less the special quality of the testing material. It is experimentally shown that the new material constants derived from a minimum number of tests can be intelligently utilized for describing other tests. A new graphical method of plotting the testing results is introduced which permits an accurate determination of the modulus of elasticity which heretofore could only be determined crudely by drawing the tangent along the tension-elongation curve. The theoretical derivations agree well with the experimental results. WH (9b)

Micro Machine with Photographic Recorder for Determination of the Mechanical Properties of Metals (Micromachines a enregistrement photographique pour l'essai mechanique des metaux) Pierre Chevenard. *Bulletin de la Societe d'Encouragement,* Vol. 134, Jan. 1935, pages 59-75. See "Machine with a Photographic Attachment Designed for Mechanical Testing of Small Test Samples of Metals," *Metals & Alloys,* Vol. 6, May 1935, page MA 200L/8 WB (9b)

An Interference Extensometer and Some Observations on the Elasticity of Lead. Bruce Chalmers. *Proceedings Physical Society.* Vol. 47, Mar. 1935, pages 352-370. Includes discussion. An extensometer using an interference fringe method for measuring extensions of specimens 3 cm. long with an accuracy of 3×10^{-7} cm. is described. Temperature uniformity is insured by immersing specimen and apparatus in a water bath. Tests on Pb wires, 3 mm. in diameter, showed that specimens not recently strained gave straight-line stress-strain diagrams up to an elastic limit of 9 kg./cm.^{2} In elastic range, elongation continued for about 3 mm. after each change of stress but then (unlike creep above elastic limit) it ceased. Effect is ascribed to thermal changes and is discussed thermodynamically. Specimens which had been recently severely strained (within a few days) gave a stress-strain curve below an elastic limit of 30 kg./cm.^{2} in the form of a closed loop, unlike usual hysteresis loop in that strain returned to initial value after each stressing. Young's modulus for strained and unstrained specimens was 1.7×10^{11} and 2.7×10^{11} dynes/cm.^{2} respectively, and the limits for elastic extension 2×10^{-4} and 4×10^{-5} cm./cm. JCC (9b)

9c. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cooperation with the A.S.T.M. Research Committee on Fatigue of Metals.

Influence of Test Bar Size and Form on Torsion Fatigue Strength of Steel (Einfluss der Probengrösse und Probenform auf die Dreh-Schwingungsfestigkeit von Stahl). R. Mailänder & W. Bauersfeld. *Technische Mitteilungen Krupp,* Vol. 2, Dec. 1934, pages 143-152. With a new torsion fatigue machine, which is described and which will test specimens up to 50 mm. diam. and 40 kg./mm.^{2}, the influence of test bar diam. was studied with a Cr-Ni-W steel of 92 kg./mm.^{2} (130,000 lbs./in.^{2}) tensile strength. The torsion fatigue strength decreased from 21 to 29% on increasing the test bar diam. from 14 to 45 mm.; hollow bars showed the least effect, while solid cylinders with transverse holes showed the greatest effect. For still greater diameters the fatigue strength appears to fall off only slightly and to approach a limit. The results are in agreement with those obtained in bending fatigue tests. More tests are needed because there is disagreement with the results of Peterson (*Transactions American Society for Steel Treating,* Vol. 18, 1930, pages 1041-1053) especially in tests of bars of uniform diam. in the length under test. Some of Faulhaber's results are confirmed (*Stahl und Eisen,* Vol. 53, 1933, pages 1106-1108). The effects of transverse holes, keyways and collars were studied; these results are in agreement with similar tests in the literature in so far as a comparison is possible. MG (9c)

Effectiveness of Tin and Zinc Coatings in Corrosion Fatigue Tests (Über die Haltbarkeit von Zinn-und Zinküberzügen bei Korrosionsdauerbeanspruchungen). J. Krystof. *Metallwirtschaft,* Vol. 14, Apr. 19, 1935, pages 305-307. Fatigue tests were made with artificial sea water flowing over the test bars. Under high loads, resulting in short tests, Zn plated steel was much superior to hot galvanized steel, which failed due to localized corrosion. Under lower loads, running up to 350 million reversals, the endurance limit was about the same with both types of coating. Electro-plated Zn has low endurance properties and numerous cracks form, resulting in local galvanic cells. Tinned steel had a much lower endurance limit than Zn coated steel. Cracks formed in the Sn layer and on account of the higher potential of the Sn, the steel soon rusted. 13 references. CEM (9c)

Effect of Occasional Overload on the Strength of Metals. H. F. Moore. *Metals & Alloys,* Vol. 6, June 1935, page 144. Brief discussion of the effect of periods of overstress and number of cycles of stress on starting of fatigue cracks. WLC (9c)

Fatigue Failure of Metals. R. A. McGregor, W. S. Burn & F. Bacon. *Iron & Coal Trades Review,* Vol. 130, Feb. 1, 1935, pages 207-208. See "Relation of Fatigue to Modern Engine Design," *Metals & Alloys,* Vol. 6, May 1935, page MA 200R/2. Ha (9c)

The Effect of Heavy Oils and Greases on the Fatigue Strength of Steel Wire. R. Goodacre. *Engineering,* Vol. 139, May 3, 1935, pages 457-458. The tests were made in the Research Laboratory of Messrs. Bruntons (Musselburgh), Limited. The new Haigh-Robertson fatigue-testing machine was used, a box being fixed to the bed plate of the machine to hold the oils and greases and to prevent splashing. The wire used was of 0.55% C steel which had been drawn 75% reduction to 0.080" diameter. The steel had a tensile strength of 94.5 tons/in.^{2} with a limiting fatigue strength in air of ±23.7 tons/in.^{2} All the oils and greases used had a bitumen base and some of them contained fillers. Tables and graphs show the results of the tests. It was found that the fatigue properties improved as the viscosity of the oil increased up to a certain point where there was a marked fall and then the limiting fatigue stress remained practically constant. The wire used for the tests was in the "as drawn" condition with the usual surface markings occurring in this type of wire. It was thought that the increase in fatigue properties caused by the heavy oils and greases was due to these surface markings being filled up and thus the concentration of stress was lessened. The filler used in some of the oils and greases of low viscosity seemed to help fill up the drawing marks which increased the efficiency of the oil. To confirm this tests were made on polished wire which was without surface markings. The use of a coating of heavy oils and greases increased the limiting fatigue stress of this polished wire by an amount ranging from ±0.9 to ±1.5 tons/in.^{2} This increase was thought to be caused by the exclusion of oxygen from the surface of the wire. Tests were made on the endurance of wire in the "as drawn" condition at stresses above the fatigue limit. It was found that the wire had a life of 125,000 stress cycles at a stress of ±28.8 tons/in.^{2} When covered with one of the oils used the stress could be raised as high as ±35 tons/in.^{2} 7 references. LFM (9c)

Fatigue of Shafts at Fitted Members with a Related Photoelastic Analysis. R. E. Peterson & A. M. Wahl. *Journal of Applied Mechanics, A.S.M.E.,* Vol. 2, Mar. 1935, pages A1-A11. The problem of fatigue of shafts with press-fitted members in rotating machinery is investigated. An ordinary press-fit member was found to decrease endurance strength of a shaft to roughly half the endurance limit of the shaft material (as determined from specimens without stress concentration); the endurance strength is somewhat higher for light press-fit pressures than for heavy pressures. German tests indicate that beyond a certain pressure, endurance strength is independent of pressure. Rubbing corrosion seems to be an important factor in reducing endurance strength. Using a grooved construction proved to be very effective means for diminishing stress concentration as revealed by photoelastic tests. Rolling the shaft surface increased endurance strength. Tests are described in full. 21 references. Ha (9c)

The Fatigue Strength of Arc-Welded Butt Joints. A. T. Scott. *Carnegie Scholarship Memoirs, Iron & Steel Institute,* Vol. 23, 1934, pages 125-138. A high-class covered electrode, a standard covered electrode, and an ordinary bare mild steel wire electrode were used in the investigation. The 3 types of butt joints have a fatigue strength of about ±9 tons/in.^{2} The fatigue strength of a butt weld as given by a plain bare low-carbon mild-steel wire electrode may be raised about 12% by using a coated electrode of high Mn content. Suitably covered electrodes tend to give more consistent results than uncoated ones. In this paper the fatigue strength of butt welds was studied entirely from a practical point of view. CW (9c)

9d. Magnetic Testing

L. REID, SECTION EDITOR

Some Experiments with Pure Metal Resistance Standards (Versuche mit Widerstandsnormalen aus reinen Metallen). Tingwaldt. *Zeitschrift für Instrumentenkunde,* Vol. 55, Mar. 1935, page 138. Experiments by Thomas (*Bureau of Standards, Journal of Research,* Vol. 12, 1934, pages 313-321), on the resistance changes of Cu, Ag, Sn, Au and Pt are summarized. EF (9d)

Influence of Magnetic Fields on Watches (Ueber den Einfluss von Magnetfeldern auf den Gang von Taschenuhren). A. Jaquerod & H. Mügeli. *Zeitschrift für Instrumentenkunde,* Vol. 55, Mar. 1935, pages 139-142. **(Influence du champ magnetique sur la marche des montres).** *Bulletin annuel de la société suisse de chronometrie,* 1933, pages 52-77. See *Metals & Alloys,* Vol. 6, June 1935, page MA 243L/2. EF (9d)

9e. Spectrography

The Accuracy of the Log Sector Method of Quantitative Spectroscopic Analysis. L. C. Martin, S. A. Burke & E. G. Knowles. *Transactions Faraday Society,* Vol. 31, Feb. 1935, pages 495-502. Contains bibliography. Factors affecting general accuracy especially in obtaining differences in lengths of spectrum lines are discussed. Due to scratches and dirt on the dry films, inaccuracies were encountered, so all plates were measured wet in an apparatus which is described. Errors of the sector of +.15 mm. to —.10 mm. were corrected to +.08 to —.02 mm. Errors in the photometric part of quantitative spectroscopic methods need not be much above 5% of a minor constituent. PRK (9e)

Spectrograph Gages Purity of Nonferrous Ingots. *Steel,* Vol. 97, July 15, 1935, page 40. Michigan Smelting & Refining Co., Detroit, is supplanting chemical methods of analysis by the spectrograph in many cases. Outlines methods and presents spectrograms of Cd with Pb content increasing from 0.00 to 0.50%, examination of 4 samples of Cd-base bearing alloys for Sn, and control analysis of German silver extrusion billets for Mn. MS (9e)

Spectrographic Analysis and Some Recent Applications to the Mineral Industry. John N. Butler. *State Metallurgical Research Laboratory, State College of Washington, Information Circular* No. 12, July 5, 1935, 19 pages. A review. AHE (9e)

10. METALLOGRAPHY

J. S. MARSH, SECTION EDITOR

Alpha-phase Boundary Line of the Copper-tin System (Über die Löslichkeitsgrenze der alpha-Phase in der Kupferzinnlegierung) S. Konobejewski & W. Tarassowa. *Physikalische Zeitschrift der Sowjetunion,* Vol. 5, No. 6, 1934, pages 848-876. Low-temperature annealing of deformed solid solution of Sn in Cu results in breakdown of α-phase and precipitation of a new phase (probably δ) whereupon the maximum solubility of Sn in Cu drops from 8.5 at. % to 4.0 at. % Sn (at 300° C.). Solubility curves of the δ (γ) phase in the α solid solution were determined in cold-worked alloys in relation to annealing temperature. It could be established that the decomposition of α bronze is related to residual stresses. The velocity of this reaction has been investigated in both directions, i.e. the solution of the precipitate and the disintegration of α phase. The effect of lattice stresses upon the course of decomposition is due to the fact that the energy level of the α solid solution has been raised. The presence of distorted lattice regions accelerates the diffusion process, leads to the formation of nuclei, and speeds up the crystallization velocity. An interpretation of the new α phase boundary line has been made with the assumption that (1) the solid solution of Sn in Cn in equilibrium with the intermediary δ (γ) phase obeys the thermodynamic law: $\ln s = \dfrac{Q}{RT} + b$ and (2) that the solubility limits correspond to equilibrium between δ (γ) phase and the solid solution at a certain degree of supersaturation, which depends on the size of the precipitated δ (γ) crystals. Based on these assumptions the dimensions and number of precipitated crystals have been calculated in relation to annealing temperature and degree of supersaturation. The dissolution speed of the δ (γ) nuclei in relation to the temperature of the preceding annealing treatment has been theoretically derived and found to be in excellent agreement with actual determinations. (See also *Metals & Alloys,* Vol. 6, Feb. 1935, page MA 69 L 7; and Vol. 6, May 1935, page MA 204 R 3.) EF (10)

X-ray Investigation of α Tin Bronzes (Röntgenographische Untersuchungen an α-Zinnbronzen). T. Isawa & I. Obinata. *Metallwirtschaft,* Vol. 14, Mar. 8, 1935, pages 185-188. Samples made from electrolytic Cu and 0 to 18% pure Sn were rolled after casting, annealed for 8 days at 650° C., then for 2 days at 500° and quenched. The lattice constants were determined by precision X-ray measurements. They increase almost linearly with increase in Sn content. Other samples were quenched from various temperatures for the determination of the solubility curve. The solubility increases from 14% Sn at the freezing point to 16% at the eutectoid temperature, 525°, then decreases abruptly, dropping to about 14% at room temperature. When supersaturated alloys are annealed at low temperatures, below 525°, precipitation from the solid solution is slow and is accompanied by lattice disturbances, as shown by indistinct diffraction rings. Samples which were turned or filed after annealing at 500° had indistinct rings. By removing the surface by etching the X-ray patterns become sharp and by this means the depth of surface affected by working several alloys was estimated. 10 references. CEM (10)

An X-Ray Investigation of Certain Copper-tin Alloys. E. A. Owen & John Iball. *Journal Institute of Metals,* Vol. 57, Apr. 1935, pages 185-204 (Advance Copy No. 700). The α-phase boundary of the Cu-Sn system between 750° and 300° C. was determined by X-ray methods. Above 500° C. it was at higher Sn contents than previously determined and below 500° C. it was at lower Sn contents. The maximum solubility (16.5%) occurs at 520° C., the temperature corresponding to the β to $\alpha + \gamma$ transformation. The parameter of the γ phase was found to lie between 17.917 and 17.924 A. U. at 480° C., but the measurements were not extensive enough to determine whether there exists a definite range of solid solubility for this phase. The ϵ phase is a solid solution the range of which does not exceed 1.5% at 380° C. The results obtained suggest that a transformation of γ to $\alpha + \epsilon$ occurs at a temperature slightly above 300° C. and that the Cu-saturated boundary of the ϵ phase is not exactly vertical between 380° and 300° C. 12 references. JLG (10)

The Rate of Polymorphic Transformations. New Investigations on Tin Pest (Die Geschwindigkeit polymorpher Umwandlungen. Neue Untersuchungen über die Zinnpest). Ernst Cohen & A. K. W. A. van Lieshout. *Zeitschrift für physikalische Chemie,* Abt. A., Vol. 173, Apr. 1935, pages 1-31. The rate of the polymorphic transformation: gray Sn $\rightleftarrows$ white Sn depends on the number of preceding transformation cycles, the preliminary mechanical and thermal treatment of the metal, the medium (e.g. air or xylol) in which the transformation takes place, and on whether or not the metal filings are being agitated during transformation. The observed relations among these factors are explained by the theory of recrystallization of van Arkel & Koets on the assumption that the mechanism of formation of new crystals during recrystallization and during polymorphic transformation is the same. Based on the new knowledge, a new method of preparation of Sn with a rate of transformation 7000 times greater than usual has been developed. ORS (10)

Accelerating Effect of Oscillating Mechanical Tension on the Precipitation of Carbides from Quenched Fe-Ni-Cr-C Alloys (Effet Accélerateur d'une Tension Mécanique Sinusoïdale sur le Revenu d'une Austénite Fer-Nickel-Chrome-Carbone Hypertrempe). P. Chevenard & X. Wache. *Comptes Rendus,* Vol. 201, July 22, 1935, pages 261-263. The precipitation of carbides from an alloy of 0.33% C, 36.3% Ni, 11% Cr and remainder Fe is noticeably accelerated when the metal is subjected to alternating stress. This holds true whether the alloy is ferromagnetic or not. FHC (10)

Interference Phenomena in Two-dimensional Crystals (Interferenzerscheinungen an zweidimensionalen Kristallen). F. Laves & W. Nieuwenkamp. *Zeitschrift für Kristallographie,* Abt. A, Mar. 1935, pages 273-278. Discusses the scattering effects by which 2-dimensional crystals manifest themselves. Distinct characteristic features can only be expected with single crystal photographs. With powder photographs, these effects are less pronounced and difficult to interpret. The effects observed on single crystals in mono- and polychromatic radiation are fully taken up. EF (10)

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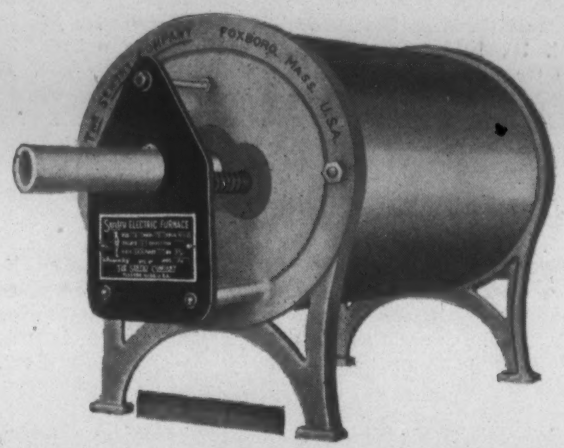

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X-Ray Investigation of the Structure of $FeAl_3$ E. F. Bachmetew. *Transactions of the Scientific Research Institute of Aircraft Materials,* No. 35, 1935, 37 pages. In Russian. See *Metals & Alloys,* Vol. 6, May 1935, page MA 205R/4. FNR (10)

Researches on Several Alloys of Magnesium, based on the Magnesium-cadmium System. Ichiji Obinata & Masami Hagiya. *Tetsu-to-Hagane,* Vol. 21, Feb. 25, 1935, pages 85-90. To the Mg-Cd alloys (1-10% Cd, 0.5-6% Cu), Ag, Zn, Hg, Al, Ti, Sn, Pb, Sb, Te, Cr, Mn and Ni were added alone or in pairs. The Rockwell hardness of these alloys in the cast, annealed, quenched and aged states as well as their corrosion resistance against distilled and natural waters and salt solutions were determined. Cu, Ni, Ag and Al considerably harden the alloys, Sn, Mn, Zn, Sb and Hg moderately and Pb and Te in very small degree. The cast alloys show always higher values of hardness than those of the annealed and the quenched ones. In the alloy containing Al or Zn, the remarkable aging effect is seen. Ni, Cu, Ag, Al, Pb, Te and Sb injure the corrodibility of the Mg-Cd alloys, whereas the presence of Sn, Zn, Mn, Hg and Ti is not very harmful. TS (10)

Phosphides and Arsenides with Modified Nickel-arsenide Structure. K. E. Flyking. *Arkiv för Kemi, Mineralogi och Geologi,* Vol. 11 B, May 6, 1935, 6 pages. In English. Powders of Mn, Fe, Co, or Ni were mixed with red P or As in the atomic proportion 1 : 1 and heated to 610° C. (phosphides) or 730° C. (arsenides) in evacuated quartz tubes for about a day. Some melts were also produced in a high-frequency furnace. Both methods furnished the same X-ray pictures. Laue and Debye-Scherrer photographs proved that MnP is orthorhombic; the density is 5.5 and the number of MnP molecules in the cell is 4. The structure resembles that of NiAs, although the latter is hexagonal. In MnP, the P atoms are not distributed so uniformly as the As atoms in NiAs. Powder photographs of FeP and CoP proved the same structure as MnP. Their lattice dimensions differ somewhat but the relative intensities of the interference lines are the same. It could not be established whether a phosphide NiP analogous to MnP exists. (A complete investigation on the Ni-P diagram is under way.) FeAs, MnAs, CoAs have the same structure as MnP. MnAs seems to differ less from NiAs than FeAs and CoAs. The following lattice dimensions have been established.

	a	b	c
MnP	5.905 A.U.	5.249 A.U.	3.167 A.U.
FeP	5.782	5.177	3.089
CoP	5.588	5.066	3.274
MnAs	6.38	5.63	3.62
FeAs	6.016	5.428	3.366
CoAs	5.96	5.15	3.57

Alloys with only a little less P than the formula MnP exhibit Mn_2P interference lines. Mn_2P was found to be analogous in structure with the hexagonal Fe_2P previously investigated by Hägg. The dimensions of the elementary prism of Mn_2P are a = 6.08 A.U., c = 3.45 A.U. WH (10)

Constitution and Structure of Silver-calcium Alloys (Constitution et Structure des Alliages d'Argent et de Calcium). CH. DEGARD. *Zeitschrift für Kristallographie,* Vol. 90, May 1935, pages 399-407. In French. Previous work on the Ag-Ca system and the Hume-Rothery rule are dealt with in the introduction. A detailed description of the preparation of Ag-Ca alloys (vacuum) is given. X-ray studies definitely proved the existence of the intermetallic compounds AgCa and Ag_3Ca. The intermetallic compounds Ag_4Ca, Ag_2Ca, and $AgCa_2$, as indicated by break points on the liquidus of Baar *(Zeitschrift für anorganische Chemie,* Vol. 70, 1911, pages 352-358), could not be verified. The alloy corresponding to the composition $AgCa_4$ was found to be a eutectic of AgCa and Ca. AgCa does not belong to the body-centered-cubic system as would be required by the Hume-Rothery rule, but is face-centered cubic ($a = 9.07$ A.U.). The ratio of the atomic radii of Ag and Ca lies within the limits given by Goldschmidt for the face-centered-cubic structure type AX : $2.41 > r_A/r_X > 0.41$ or $r_{Ag}/r_{Ca} = 2.035/2.78 = 0.73$. By using the Hull-Davey method it was established that Ag_3Ca is tetragonal with $c/a = 0.88$. EF (10)

Recent Progress in Metallography (Recenti Progressi nella Metallografia). G. GUZZONI. *Industria Meccanica,* Vol. 17, May 1935, pages 387-395. Methods recently added to the tools of metallographic study, as X- and γ-rays, the electron microscope, photography with mesothorium and in polarized light, are described, their principles explained, and their application illustrated.
Ha (10)

Aluminum-rich Alloys of the Ternary System Aluminum-tin-manganese (Die aluminiumreichen Legierungen des Dreistoffsystems Aluminium-Zinn-Mangan). ALFRED SCHÜCH. *Zeitschrift für Metallkunde,* Vol. 27, Jan. 1935, pages 11-18. The constitution, microstructure, and physical properties of the Al-rich Al-Sn-Mn alloys in the composition range 0-20% Sn and 0-6% Mn were studied. The Mn concentration of the binary Al-Mn eutectic is lowered by Sn additions from 3% Mn at 0% Sn to about 2% Mn at 20% Sn. In this range the eutectic temperature falls from 649°C. at 0% Sn to 621°C. at 20% Sn. A ternary eutectic (Al-Sn-Al_7Mn occurs at 228°C., the composition of the pure eutectic lying somewhere near 100% Sn. The compound Al_7Mn, appearing as a primary constituent as well as a constituent of the binary and ternary eutectics, is a very hard material appearing blue-gray under the microscope. A linear increase was observed in the density of the binary Al-Sn alloys from 2.74 at 0% Sn to 3.74 at 20% Sn. Additions of Mn decreased the density slightly. The Brinell hardness of the ternary alloys was increased linearly by Mn additions up to 3%, beyond which no further increase was found. Sn decreased the hardness of all alloys, but most markedly of those containing the greatest quantities of Mn. Both Sn and Mn additions lowered the impact values progressively. No noteworthy age-hardening effect was found. The corrosion resistance of the binary Al-Sn alloys in dry and moist air and in water was improved noticeably by Mn additions up to 2%. The ternary alloys were found to machine well and to take an excellent polish, but presented some difficulty in hot and cold working. 17 photomicrographs, 8 diagrams. FNR (10)

Electric Conductivity of Ternary Solid Solutions. KEIJI YAMAGUCHI & KÔZO NAKAMURA. *Scientific Papers & Abstracts Institute of Physical & Chemical Research, Tokyo,* Vol. 14, Feb. 1935, page 5. In English. The relationship between electric conductivity and composition was determined for the following 5 cases in which the intermediate phase of a binary alloy A-B forms a solid solution with the intermediate phase of another binary alloy A-C.

	Solvent	Solute	Solubility
1)	Cu_5Zn_8	$NiZn_3$	complete
2)	ϵ of Cu-Zn	ϵ of Ag-Zn	"
3)	Cu_5Zn_8	$Cu_{31}Sn8$ (δ)	incomplete
4)	Cu-Zn	NiZn	complete at high temp.
5)	Cu_5Zn_8	γ of Ag-Zn	incomplete

With the exception of case (4), there was always a linear relationship between the composition by weight and the specific resistance. Consequently the inverted U type usually present in binary solid solutions could not be found. Regarding (4) a resistance-composition curve was obtained which lies between both types of curves. All test pieces were homogenized at elevated temperatures. WH (10)

Microscopic Investigation of Precipitation in Copper-silver Alloys (Mikroskopischer Nachweis des Ausscheidungsverlaufs bei Kupfer-Silber-Legierungen). H. BUMM. *Metallwirtschaft,* Vol. 14, May 31, 1935, pages 429-431. Alloys of Cu with 7 and 10% Ag were melted, cold rolled, annealed 80 hours at 800° C., quenched in water, and reheated at 350° for various periods. Specimens were etched in 50% NH_4OH in alcohol and examined microscopically. The 7% Ag alloy after quenching showed a typical solid solution consisting of light colored crystals. Reheating produced an increasing amount of dark colored constituent, originating at the grain boundaries, and consisting of almost pure Cu. The 10% Ag alloy was similar, except that about 2% Ag was not in solution after quenching, but appeared as a white constituent between the grain boundaries. After reheating, even after 300 hours at 400°, no Ag was visible under the microscope, indicating that it must be in a highly dispersed condition. After reheating at 550°, and after severely cold working and then reheating at 350°, the Ag particles coagulated slightly and could be seen at high magnification. These results agree with X-ray determinations. The Brinell hardness-time at 350° curve was very similar to the % precipitation-time curve, where the % precipitation was determined from the photomicrographs. The hardness gradually increased and reached its maximum at 6 hours, remaining constant thereafter. When the alloy was reheated sufficiently to coagulate the Ag, the hardness decreased slightly. 8 references. CEM (10)

Fe-Ni-Cu Alloys of High Initial Permeability (Ueber Eisen-Nickel-Kupfer-Legierungen hoher Anfangspermeabilität). O. v. AUWERS & HANS NEUMANN. *Wissenschaftliche Veröffentlichungen aus den Siemens-Werken,* Vol. 14, Mar. 25, 1935, pages 93-108. In the Fe-Ni-Cu system there is a zone of high initial permeability and low coercive force, containing alloys whose compositions vary from 80% Ni, 20% Fe to 40% Ni, 50% Cu, 10% Fe. In the greater part of this region the alloys with higher initial permeability have a negative coefficient of magnetostriction. The ternary diagram has been carefully explored with respect to these two properties. MG (10)

11. PROPERTIES OF METALS AND ALLOYS

A Study of Certain Finely Divided Metals and the Method for their Preparation. E. G. INSLEY. *Journal of Physical Chemistry,* Vol. 39, May 1935, pages 623-636. Finely divided metals are prepared from their amalgams by distilling off the Hg and an investigation of the catalytic activity of finely divided metals prepared in this way has been undertaken. The metals studied were Fe, Co, Ni and Cu and each metal was prepared from both the oxide and the amalgam. The adsorption of H on Ni has been studied at temperatures from —80° to 150°C. It is shown that only a very small part of the total adsorption is due to "physical adsorption." The second manner of "sorption" could be explained by Taylor's theory of "activated adsorption," or by a solution of the gas in the metal or possibly by a combination of the two. EF (11)

Photoelectric Fatigue and Oxidation. J. S. HUNTER. *London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science,* Vol. 19, May 1935, pages 958-964. The nature of the change undergone by a clean metallic surface on exposure to air is discussed and present theories are reviewed, although they do not give an absolutely satisfactory explanation. The most acceptable seems to be that when a clean metallic surface is exposed to air there is an instantaneous adsorption of gas by the surface and true oxidation begins only after a certain time depending on the kind of metal. This time is short for Fe, longer for Cu, Ag, Bi and Ni. Once oxidation has begun the subsequent rate of oxidation then depends on the rate of condensation of oxygen at the oxide-oxygen interface. The photoelectric currents emitted by the oxide surfaces were determined.
Ha (11)

On Cold Shortness of Metals and Alloys. YOSHIRO FUJII. *Kinzoku no Kenkyu,* Vol. 12, Apr. 1935, pages 189-209. In Japanese. Cold shortness of 37 commercial metals and alloys such as steel, Ni steel, Cr steel, Mn steel, Cu-Al, Cu-Sn, Cu-Zn, Cu-Ni, Ag, Pb, Zn, Mg, Sb, etc. were investigated at temperatures between —190° and 500°C. by Izod and Charpy impact machines. X-ray analysis was also utilized when necessary. The results are as follows: cold shortness depends mainly on the type of crystal structure; metals crystallizing in the face-centered cubic lattice are free from cold shortness, while metals crystallizing in other lattice structures are cold short at certain low temperatures. Sorbitic steel is cold short at a lower temperature than pearlitic but the cold short temperature increases with the C content. KT (11)

11a. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

Asarcoloy No. 7—A Cadmium Nickel Bearing Alloy. *Automotive Industries,* Vol. 72, May 18, 1935, page 678. This Cd base bearing metal is said to have greater fatigue resistance, greater toughness, greater strength, more ductile bond and a higher melting point than conventional babbitts. It contains from 0.75 to 3% Ni, increasing Ni content giving decreased ductility but increased strength and hardness. Differing from other Cd alloys the Cd-Ni alloy bonds directly with steel by a slight Ni penetration, without formation of an intermetallic compound at the bond. Less tendency to sludge lubricating oil than babbitt is claimed.
BWG (11a)

X-Ray and Hardness Tests of Nickel Rich Nickel-Tin Alloys (Röntgenographische und Härteuntersuchungen an nickelreichen Nickel-Zinn-Legierungen) ERIC R. JETTE & ERICH FETZ. *Metallwirtschaft,* Vol. 14, Mar. 1, 1935, pages 165-168. Electrolytic Ni containing .013% Fe and .11% Co and Sn containing .003% Pb and .002% Fe were used for making the alloys containing up to 33.38% Sn in a high frequency induction furnace. After annealing at 1000° C. the alloys were powdered, heated in sealed and evacuated glass or quartz tubes to temperatures up to 1100° and quenched in water, crushing the tubes. Lattice parameters were determined by X-ray examination and from these the solubility of Sn in Ni calculated. The values obtained were 1.9% at 500°, 11.5% at 750°, 18.7% at 1000°, 19.7% at 1100°. Another set of samples was chill cast, annealed, quenched from 1050° and reheated to 500° and 600° for periods up to 1000 hours. Hardness tests were made at regular intervals. The 20% Sn alloy increases from 250 to 490 Brinell hardness after reheating 80 hours at 500° and the 15% alloy from 220 to 400 after 300 hours. After continued heating the hardness is only slightly reduced. At 600° the maxima are reached in a shorter time, but are not as high. The hardness in the as cast, annealed, and heat treated states has a linear relation to the Sn content. The 24% Sn alloy consists of 2 constituents, the new one being identified as Ni_3Sn by X-ray examination. CEM (11a)

Test Results of Zinc Alloy Die Castings Containing Aluminum (Untersuchungsergebnisse an aluminiumhaltigen Zink-Spritzguss-Legierungen). WILLI CLAUS. *Metallwirtschaft,* Vol. 14, Jan. 25, 1935, pages 67-68. Tensile strengths, elongations, Brinell hardnesses and impacts were determined on 2 groups of alloys: No. 1 containing .1% Mg, 2.5% Cu, 4.5% Al, balance Zn; No. 2 containing .1% Mg, 4.0% Cu, 2.5% Al, balance Zn. Three grades of Zn were used: Refined Zn, 98.8-98.9% pure, "Giesche" electrolytic Zn, 99.975-99.99% pure, and "Nor" electrolytic Zn, 99.975-99.99% pure, and to some of the test pieces .03% Li was added. Tests were made monthly up to 7 months natural aging. Alloy No. 1 had higher tensile, elongation and impact than alloy No. 2, regardless of the grade of Zn used. Better properties, especially elongation and impact, were obtained by the use of the purer Zn grades. The addition of .03% Li increased the tensile of alloy No. 1 about 18% and the impact of alloy No. 2. Natural aging did not lower the physical properties, except the hardness and impact of alloy No. 2 made with the 98.8% Zn. Alloy No. 1 made with the purer Zn and with .03% Li did not grow or change in physical properties noticeably after aging 35 hours in water vapor at 96° C. and 2 hours in paraffin at 180°-200°. This alloy can be cold rolled, resulting in 62 kg./mm. tensile strength and 2.5% elongation.
CEM (11a)

The Effect of Additional Metals, Especially Silver, on the Transformation Hardening of Gold Copper Alloys (Der Einfluss von Zusatzmetallen, besonders von Silber auf die Umwandlungshärtung der Gold- Kupfer- Legierungen). J. Spanner & J. Leuser. *Metallwirtschaft,* Vol. 14, Apr. 26, 1935, pages 319-322. The hardness of annealed Cu-Au alloys can be considerably increased by heating them to 200°-400°C. Starting with 75% Au and 25% Cu and replacing both with increasing amounts of Ag, the maximum obtainable increase in hardness in % is about the same, but with increasing Ag content the temperature must be raised to obtain maximum increase in hardness. By adding 30-40% of either Cu or Au to the alloy AuCu, its transformation and hardness increase can be prevented. The maximum obtainable increase in hardness, both by heat treatment and by cold working, is greater in alloys which are comparatively soft in the annealed condition than in the harder ones. The addition of up to 3% Al to some Au-Ag-Cu alloys increased their original hardness considerably, but heat treatment did not raise it much more. Additions of Pt and Ni up to 10% have a similar effect and Pt also reduces the grain size. Some alloys containing 30-50% Au can be hardened only slightly, but by the addition of 10-15% Zn it is possible to increase their hardness 98% by heat treatment. On other alloys Zn has no effect. 8 references. CEM (11a)

Nickel—Past and Present. Robert C. Stanley. *Transactions Canadian Institute of Mining & Metallurgy,* 1935 (in *Canadian Mining & Metallurgical Bulletin* No. 277, May) pages 176-208. The early history of the extraction, refining, and use of Ni is reviewed and present industrial uses discussed in detail. The compositions of 131 steels containing Ni are tabulated as well as analyses of 63 other Ni alloys. Wrought Ni steels, cast Ni steels, corrosion-resistant steels, heat resisting and electrical resistance alloys, Ni-Fe alloys, Ni cast-Fe, Ni silvers, Ni brasses and bronzes, Cu-Ni alloys, Ni coinage, Ni plating, Ni for storage batteries, Ni catalyzers, light alloys, malleable Ni, Ni-clad steel, Monel metal, and Inconel are discussed. AHE (11a)

Cast Aluminum and Its Use in Modern Automobile Construction (Aluminiumguss und seine Verwendung im modernen Kraftfahrzeugbau). O. Summa. *Automobiltechnische Zeitschrift,* Vol. 38, June 25, 1935, pages 297-301. Physical properties of Al alloyed with Cu, Zn, Si and Mg, metallographic features and compositions especially used for automobile parts are reviewed. Ha (11a)

Zirconium and Its Uses. L. Sanderson. *Sands, Clays & Minerals,* Vol. 2, June 1935, pages 47-50. Occurrence of Zr ores, methods of extraction, sources of supply and uses, at present not very numerous, are reviewed and physical properties given. The most important use is as ferrozirconium, made in the electric furnace by reduction of a mixture of Zr and Fe ores, or by fusion of a mixture of Zr, cast Fe, lime and fluorspar, or by reduction of mixed oxides and Al. It contains about 30-40% Zr and small amounts of C, Al, Ti. In steel production it acts as scavenger, similar to ferrotitanium by elimination of N and oxides. It is said to ensure sound castings and to increase strength and resistance to acids. Claims made that Zr steels have better mechanical properties have not been substantiated. Ha (11a)

The Chemistry of Germanium (Ueber die Chemie des Germaniums). Robert Schwarz. *Angewandte Chemie,* Vol. 48, Apr. 13, 1935, pages 219-223. The present knowledge of properties of Ge is reviewed, chemical compositions are described, and its metallurgy discussed. It is very similar to Si and forms a bridge between the pronouncedly non-metallic and the metallic elements. The constitutional diagram of a Ge bronze, Cu-Ge, was established. Cu can dissolve 10 atomic % Ge by forming solid solutions. The latter are subject, at 828°C., to a peritectic transformation into β-solid solutions which show a new peritectic transformation at 744°C. into γ-solid solutions with about 23 atomic % Ge. The only compound in the system Cu-Ge, Cu_3Ge, is precipitated from the γ-phase and the melt at 700°C. This compound is subject to a transformation in solid state at 615°C. On the other side of the system, beyond 10% Ge, no solid solutions are found, a eutectic occurs at 35 atomic % Ge and solidifies at 650°C. The alloys are all resistant to HCl and concentrated H_2SO_4. Concentrated HNO_3 attacks alloys with up to 25% Ge. Beyond this only aqua regia has an effect. Hardness of Cu is increased considerably by Ge, but brittleness increases. The system Au-Ge does not form solid solutions; the eutectic lies at 359°C. with 24 atomic % Ge. Germanates are formed like silicates and can replace Si in the latter. The metal itself is a silver-white, brittle material with a m.p. of 958°C. A number of compounds with N, Sn and Pb and a few organic compounds were studied. 12 references. Ha (11a)

Further Studies Concerning Electrical Conductivity of Metallic Solid Solution Phases at Lower Temperature (Cu-Pt Alloys) [Weitere Untersuchungen über die Elektrische Leitfähigkeit Metallischer Mischphasen in Tiefer Temperatur (Cu Pt-Legierungen)]. H. J. Seemann. *Zeitschrift für Physik,* Vol. 95, Apr. 4, 1935, pages 97-101. Electrical resistance measurements were made of two Cu-Pt alloys, one with 70 and the other with 75 atomic % Pt after various heat treatments. Annealing at 400°-550°C. lowers the specific resistance measured at room temperature. FHC (11a)

Free Energy and Heat of Formation of the Intermetallic Compound CdSb. Harry Seltz & J. C. De Haven. *Metals Technology,* June 1935, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 622, 7 pages. Thermodynamic properties of the compound CdSb were determined by an electromotive force method. For the reaction, $Cd(s) + Sb(s) = CdSb(s)$, $\Delta F = —3486 + 1.067T$, and $\Delta F_{298} = —3168$ cal.; $\Delta H = —3486$ cal. Entropy change in the reaction is small: $\Delta S_{298} = —1.1$ cal. $deg.^{-1}$ and for CdSb, $S_{298} = 21.7$ cal. $deg.^{-1}$. JLG (11a)

Embrittlement of Uranium by Small Amounts of Aluminum and Iron. H. W. Highriter & W. C. Lilliendahl. *Metals Technology,* June 1935, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 630, 5 pages. Ductile U can be prepared from the metal produced electrolytically in a molten bath of KUF_5. It was found that the material was embrittled by about 0.2% Al or 0.5% Fe, or by smaller amounts when in combination. Small amounts of carbide do not seem to affect ductility. The impurities Al and Fe were introduced into some batches of U from the graphite crucibles used in electrolysis. Al or Fe in U causes a second phase to form in the grain boundaries. JLG (11a)

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The Non Ferrous Products of Present Interest (Les Produits non Ferreux à l'Ordre du Jour) P. Bastien. *La Technique Moderne,* Vol. 27, May 15, 1935, pages 318-325. Present trend is towards production of alloys having (1) high mechanical strength, (2) high corrosion resistance. Article reviews the following alloys: (1) Copper alloys. Special attention is given to high strength alloy brasses and Cu-Be alloys, the latter having the following properties after correct heat treatment: Hardness = 400. Tensile strength = 150 $kg./mm.^2$. Elongation = 2-3%. (2) Al and its alloys (forge and foundry alloys without or with heat treatment). It is pointed out that trend is to use very pure metals for making alloys. In foundry practice it is customary to add Ti for refining structure or to use correct heat treatments. In forge practice Mg-Al alloys are used more and more. (3) Mg and its alloys. Disadvantage of these alloys is their corrodibility under atmospheric exposure. (4) Zn and its alloys used in die casting. It is shown that in this type of application Zn used must be of high purity. (5) Modern bearing metals: Nothing new is brought out in this connection. FR (11a)

Zinc Base Alloys (Legierungen auf Zink-Grundlage) Willi Claus. *Zeitschrift Verein deutscher Ingenieure,* Vol. 79, Mar. 23, 1935, pages 385-386. The increasing importance (especially in German metal economics) of Zn alloys is discussed. They are mostly used for die-casting and are divided into Cu-rich, 2-3% Cu, Cu-poor, less than 1.25%, or Cu-free alloys. The Cu-rich alloys have much better properties and are practically non-aging. They should be used where they do not have to stand temperatures over 95°C. Cu-poor or Cu-free alloys should be used only in special cases. Additions of other elements change the properties. Al is a valuable element and is present in all Zn-Cu alloys ranging from 4-20%, and with additions of from 0.02-0.10% Mg. These alloys are practically free from the intercrystalline corrosion which was formerly so often observed in Zn-Cu-Al alloys. Sn is very harmful and should not be present in amounts of more than 0.001%. Cd is less harmful and should be limited to 0.005%. Fe, Ni, Mn and Si exert comparatively little influence on the mechanical properties. About 0.03% Li seems to be beneficial. The Zn used in the alloys should be of highest purity, at least 99.99%. Ha (11a)

Precious Metals as Materials of Construction. Fred E. Carter. *Industrial & Engineering Chemistry,* Vol. 27, July 1935, pages 751-755. 8 references. As construction materials the precious metals and their alloys are perhaps often hurriedly dismissed as being too expensive for consideration. The paper points out that sometimes the longer life, the improvement in the product, and the high resale value of these materials may well compensate for the higher initial cost. Emphasis is given to properties and uses of the Pt metals, and Au and Ag are also discussed. Tabulated information is given for the relative costs, specific gravity, m. p., Brinell hadness, effect of chemical reagents. Charts are included showing the hardening effect on Pt and Pd, of 10% additions of other metals. MEH (11a)

Adsorption of Gases on Mercury. R. S. Burdon. *Proceedings Physical Society.* Vol. 47, May 1935, pages 460-470. Air, CO_2, and H to the extent of a monomolecular layer were found to be retained by a Hg surface in a vacuum for long periods after the gas was pumped off. On breaking the Hg surface, the gas was evolved. JCC (11a)

The Magnetic Properties of Amorphous Manganese. L. F. BATES & D. V. REDDI PANTULU. *Proceedings Physical Society,* Vol. 47, Mar. 1935, pages 197-204. Pure amorphous Mn, prepared by heating pure Mn amalgam *in vacuo,* is definitely non-ferromagnetic. The susceptibility per gram at 20° C. is 11.80×10^6, and over the range of temperature 90°-600° K obeys the Curie-Weiss law, being $2.174 \times 10^{-2}/(T + 1540)$. JCC (11a)

Recent Investigations on Zinc with Particular Consideration of Electrolytic Zinc (Neure Forschungen über Zink unter besonderer Berückichtigung des Elektrolytzinks) O. BAUER. *Zeitschrift Vcrein deutscher Ingenieure,* Vol. 79, June 1, 1935, pages 681-683. A general review of the metallurgy of Zn and effect of foreign metals on its physical properties. Sn and Mg reduce shrinking of cast Zn considerably, Cd to a lesser degree, Sb has the same effect only up to 0.7%. Cu has no effect but increases hardness and impact strength. Pb has practically no effect. Fe has in general a harmful effect as it deteriorates impact strength and increases hardness. Zn can be rolled at all temperatures, Pb up to 1% has no effect, Cd only above 0.25% and Cu up to 1% and rolling temperatures above 110° C. very little. Sb is harmless, Fe even in 0.1% very harmful but rolling temperatures above 150° can compensate the effect somewhat. Sn is always harmful. Tensile strength and elongation are most harmfully affected by Bi, Sb and Th, while As and Pb have not much effect. Cd, Mg and Li increase strength but reduce elongation. Al, Ni and Cu increase strength without reducing elongation very much. Corrosion resistance of electrolytic Zn is generally greater in neutral waters than that of refined Zn, but if H is developed in the attack electrolytic Zn is dissolved faster. Electrolytic Zn of 99.98% purity is an excellent material for die-casting. Available data on castability, alloying for die-casting are reviewed. 15 references. Ha (11a)

Piston Alloys (Über Kolbenlegierungen) E. BERTRAM. *Deutsche Motorzeitschrift,* Vol. 12. Apr. 20, 1935, pages 74-76. EUGEN NITZSCHE. *Deutsche Motorzeitschrift,* Vol. 12, May 20, 1935, page 86. Polemic against a previous article by O. Summa (See *Metals & Alloys,* Vol. 6, Feb. 1935, page MA 71 R-6) on physical properties and heat treatment of Si-bearing piston alloys. By means of several microstructures the service properties and thermal treatment of light alloy pistons are discussed critically and a comparison with the behavior of bearing alloys is made. Bertram points out that low additions of Fe, Cu, Ni, Mg shift the eutectic point of Silumin (12.8-13.2% Si light metal alloy) so that the microstructure can be eutectic or hypereutectic, although the Si content remains constant. It is doubted that a refinement of the hard, Si-rich constituent can be accomplished in Nüral piston alloys by thermal treatment only. Grain size and distribution depend on the number of nuclei and crystallization speed during solidification. A finer distribution of the Si-rich crystals in the hypereutectic alloy KS 280 (22% Si) previously reported by Sterner-Rainer (*Zeitschrift für Metallkunde,* Vol. 26, 1934, page 144) is secured by special additions (for instance Na) to the melt. In hypereutectic Al-Si alloys, no volume increase due to the precipitation can take place in service since practically no Si is held in solution in Al. A heat treatment is required due to the fact that the heavy metals are in solid solution in the as-cast state. The determination of hardness at elevated temperatures is critically discussed. The precipitation hardness is not lost at temperatures up to 200° C. Contrary to statements by Summa, it is pointed out that Cu lowers the thermal conductivity of Al-Si alloys and improves the casting properties. Nitzsche corrects Summa on some incorrect citations from his work "Thermal Expansion of Al-Cast Alloys by Additional Metals," Verlag K. Triltsch, Würzburg. WH (11a)

11b. Ferrous

V. V. KENDALL, SECTION EDITOR

Density of Copper-bearing Electrolytic Zinc in Relation to Its Deformation by Hot and Cold Rolling (Die Dichte von kupferhaltigem Elektrolytzink in Abhängigkeit von der Verformung durch Warm- und Kaltwalzen). P. ZUNKER. *Zeitschrift für Metallkunde,* Vol. 27, Jan. 1935, pages 19-23. The density of alloys of electrolytic Zn (99.982%) with additions of 0-2% of electrolytic Cu was measured after hot (175° C.) and cold rolling at intervals of 10% reduction in thickness. The weighing media for the density measurements were air and water. With additions of Cu a linear increase in the density of cast specimens of from 7.1332 at 0% Cu to 7.2002 at 2% Cu was found. In accordance with previous findings (O. Bauer & P. Zunker, *Zeitschrift für Metallkunde,* Vol. 25, 1933, page 150; *Metallwirtschaft,* Vol. 11, 1932, pages 289, 303) the density of pure Zn was found to decrease at first upon hot working and then after 30-40% reduction to return to its original value, suffering a final slight decrease in the density at about 90% reduction. The same behavior was observed in the Cu-bearing Zn with Cu additions up to 0.98%. The magnitude of the density changes was greater in the alloys with up to 0.36% Cu than in pure Zn. An alloy with 2% Cu, however, showed almost no influence of working upon its density. Upon cold rolling after 61% of previous hot rolling a slight increase in density followed by a final decrease at 80% total reduction was found. Cold working after higher degrees (70%) of previous hot working produced only a slight and continuous decrease in the density. In all cases the final density at about 95% reduction was lower than that of the pure metal. The failure of the 2% Cu specimens to exhibit density changes upon working is attributed to their initial fine grain size. All of the alloys with less than 1% Cu had large acicular grains when in the cast state, while those of higher Cu contents had fine equiaxed grains. A study of the influence of combined hot and cold working upon the grain size was made. FNR (11b)

Magnetic Aging of Iron Due to Oxygen. T. D. YENSEN & N. A. ZIEGLER. *Metals Technology,* June 1935, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 624, 8 pages. Three sample rings of very pure Fe were prepared. These were heated in air at 900, 800, and 700° C. for 1 hr. in order to introduce different amounts of O. They were quenched in air. They were then heated in vacuo to different temperatures and their magnetic properties determined after each heating. The hysteresis loss increased at increased heating temperatures until 400° C. and then fell. The maximum permeability decreased as the hysteresis loss increased. The change in magnetic properties was attributed to precipitation of oxide. The samples contained 0.019, 0.029, and 0.035% O. JLG (11b)

Introduction to the Knowledge of Special Steels (Einführung in die Sonderstahlkunde). E. HOUDREMONT. Julius Springer Verlag, Berlin, 1935. Cloth, 7 x 10 inches, 566 pages. Price 52.50 RM.

The author, works director at Krupp's, in Essen, is in position to discuss his subject with authority. He defines special steels as those having properties different from those of tonnage steels, by virtue of composition, preparation or treatment. Thus a steel of common composition that can be made either in the converter or the electric furnace would be classed as a special steel when the latter melting method confers superior properties. Notwithstanding this definition, the author pays very little attention to the properties resulting from varieties in melting methods and deoxidation practice. Controlled grain size practice is not mentioned save for a brief comment on the effect of vanadium, and of nitrogen in the chromium steels. The non-aging properties of Izett steel are mentioned, but in general, the effects of deoxidation ,of cooling rate, and the other factors resulting from variables acting on the liquid steel are disregarded, chief stress being put upon chemical composition and heat-treatment, and only minor comment being made on deoxidation by Si and Al. Generally speaking, only wrought steels are dealt with, comments on cast steel being but rarely interspersed. Houdremont has not attempted to give complete references to the literature since he says this would take a book in itself. The references that are given are overwhelmingly to German literature. In a few cases where the work of American, English, French, Japanese, Swedish and Russian authors has to be mentioned and their data used, he cites them but wherever it is possible to get the main facts from the work of Germans, he does so. It is a bit surprising to find no reference made to the A.S.T.M. work on corrosion resistance of copper steels. Some of the more comprehensive and important recent treatises on alloy steels in English are entirely disregarded. In several cases these books go much farther and give much more information than does the present volume. It is a large task to attempt to discuss carbon steels in 117 pages and those alloyed with Mn, Ni, Cr, W, Mo, V, Co, Si, Al, Cu, O, N, H, P, S, Ti, Be, B, Cd, Nb, U, Zr, and Ce in the balance. Yet there is a great deal of information much being presented in small space by the copious use of plots of properties. Many important facts are dismissed with a single sentence each and the reader may easily fail to grasp their importance. However a vast amount of clearly-presented and well-chosen data is given, a good deal of it being the result of very recent work. The necessity for brevity leads to a rather crisp mode of presentation in relatively short sentences so that it is more easily grasped than much technical German. Houdremont seldom fails to have and to express a very definite opinion on any point he mentions. The book is expensive, but worth its price, since it brings so much between one pair of covers. The paper, typography, illustrations and binding are of very high quality. H. W. Gillett (11b)—B—

Aluminum Cast Iron (Les Fontes a l'Aluminium). G. D'ARDIGNY. *Revue de Fonderie Moderne,* Vol. 29, May 10, 1935, pages 157-158. Some recent tests show that the graphitizing action of Al in cast Fe is irregular. Up to 8% it is inferior to that of Si and for contents from 8 to 15%, the graphite disappears entirely, but appears again for more than 15%. The mechanical properties are improved up to 2% only, beyond that it is detrimental. The resistance against heat oxidation is increased by additions of 2-18% Al, and 2-15% increase the corrosion resistance against saline solutions. A typical cast Fe with good mechanical properties and heat resistance is composed of 2.5% C (total), 2.3% Si, 0.77% Mn, little P and S and not more than 6% Al. Ha (11b)

Determination of the Change in Volume of Iron on Solidification. G. ERICSON. *Carnegie Scholarship Memoirs, Iron & Steel Institute,* Vol. 23, 1934, pages 13-45. Fe during solidification contracts 2-4% of the volume of the solid Fe. The method of surface solidification was used in this work. In this method the apparent and real specific volumes of a mass (preferably spherical), solidified from outside to center and containing a cavity, are determined, and from the results are calculated the volume change during solidification. The method of surface solidification was also used in the determination of the freezing expansion of gray cast Fe, but the results were less reliable than in the case of pure Fe where a contraction rather than an expansion occurs during freezing. The value $\frac{dv}{v} = +1.2\%$ for gray cast Fe is believed to be low. On the surface of the cast iron a small sphere of metal appeared which was pressed out during the freezing, which shows that expansion actually takes place during solidification and not, as often supposed, afterwards in the solid state. In pure Fe and low C steel, the Fe crystals formed in the liquid have a tendency to sink. This was previously believed to be true, but had been disputed. CW (11b)

Survey of Magnetic Materials in Relation to Structure. W. C. ELLIS & EARLE E. SCHUMACHER. *Bell System Technical Journal,* Vol. 14, Jan. 1935, pages 8-43. Previously published in *Metals & Alloys,* Dec. 1934, and Jan. 1935. See *Metals & Alloys,* Vol. 6, May 1935, page MA 207L/9. WB (11b)

A Comparison of the Properties of Molybdenum Alloy Cast Iron and Chromium Alloy Cast Iron Automobile Engine Cylinders. J. E. HURST. *Iron & Steel Industry,* Vol. 7, Aug. 1934, pages 351-354. Investigations have been carried out on ring specimens taken from one of the actual cylinder barrels cut out of 2 six cylinder monobloc castings in such a manner that the properties measured are those associated with the actual material constituting the cylinder wall. Chemical analysis of cylinder barrels S and M are as follows:

	Barrel S	Barrel M
T. C.	3.12 %	3.03%
G. C.	0.88 %	0.88%
Si	2.03 %	2.15%
Mn	1.07 %	1.01%
S	0.147%	0.096
P	0.278%	0.361
Mo	Nil	0.22%
Cr	0.14 %	0.09%
Ni, Cu, V, Ti	Nil	Nil

From each barrel a complete set of 17 rings starting from the explosion end to the mouth end, was obtained and used for each determination of the various mechanical properties. Brinell hardness shows irregularities with the hardness of the Mo iron substantially higher than those of the standard Cr alloy material. Permanent set value of Mo cast iron is lower as compared with that of Cr alloy cast iron. The modulus of elasticity and modulus of rupture for the Mo cast iron cylinder are higher than those of the Cr alloy material. CEJ (11b)

Progress and Development in Cast Iron During 1934. J. E. Hurst. *Iron & Steel Industry,* Vol. 8, Feb. 1935, pages 169-170, 178. A brief review is given of the leading papers on cast iron that have appeared in 1934. Comment is made regarding British, American and Continental work. CEJ (11b)

Age Hardened Steel Avoided Rather Than Utilized. Paul D. Merica. *Metal Progress,* Vol. 27, June 1935, pages 29-32. Describes age hardening properties of low C steel following a solution quench and cold work, effects of elements such as Cu, N are mentioned. "Work aging" and blue brittleness are discussed in light of their possible relation to precipitation hardening. WLC (11b)

Aluminum-Manganese-Silicon Cast Irons. A. L. Norbury & E. Morgan. *Carnegie Scholarship Memoirs, Iron & Steel Institute,* Vol. 23, 1934, pages 107-124. The authors give a survey of the microstructures, Brinell hardnesses, transverse strengths, magnetic permeabilities and electrical resistivities of cast irons containing up to 6% Al, between 6 and 19% Mn and up to 5% Si. They found that an alloy containing about 3.5% C, 3% Si, 9% Mn, and 3% Al is not greatly inferior in machinability and non-magnetic properties to ordinary non-magnetic cast irons. This alloy is much cheaper than the ordinary non-magnetic cast irons. In general, lowering the total C below that given above improves the strength, but the tendency to mottle in thin sections is increased. Higher Si and Al contents lower the strength and toughness. Lower amounts increase the tendency to mottle. Increasing the Mn content increases the tendency to mottle, and decreasing it below 7% causes the Fe to become magnetic. CW (11b)

Effect of Antimony in Pearlitic, Martensitic and Austenitic Cast Iron (Ueber den Einfluss von Antimon in perlitischem, martensitischem und austenitischem Gusseisen). E. Piwowarsky. *Giesserei,* Vol. 22, June 7, 1935, pages 277-280. Although additions of 0.5-0.6% Sb increase the resistance of gray Fe to lyes, the mechanical properties are lowered by about 30%, even with 0.2-0.3% Sb. Recent experiments showed, however, that Ni additions offset the harmful effect of Sb on the mechanical properties, but the P content should not exceed about 1.5%. The ratio of Ni to Sb should be 6:1 to 8:1. Also, the wear resistance is considerably increased in this type of cast Fe, particularly in martensitic cast Fe with Sb; a kind of precipitation hardening seems to occur. The study of the system Fe-C-Sb is recommended as possibly some important technical applications might be found, especially of the martensitic cast irons. 7 references. Ha (11b)

Directional Properties in Rolled and Annealed Low Carbon Steel. Arthur Phillips & H. H. Dunkle. *Transactions American Society for Metals,* Vol. 23, June 1935, pages 398-408. Paper read and discussed at A.S.M. Convention, 1934. Previously abstracted from Preprint 24. See *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 536. WLC (11b)

Chromium-Copper Steel (L'acier au Chrome-Cuivre). L. Persoz. *La Revue Industrielle,* Vol. 65, May 1935, pages 200-204. Si steel was first substituted for ordinary C steel in steel constructions: bridges, poles, buildings, etc. Although having higher resistance and elastic limit this steel showed some disadvantages; it is difficult to weld, difficult to hot work, and was as corrodible as common steel. Cu steel was then adopted which has mechanical properties equal to those of C mild steel but has a corrosion resistance to atmospheric conditions 5-7 times that of ordinary steel. More recently Cr-Cu steel containing 0.3-0.5 Cr, 0.25-0.60 Cu and 0.18-0.22 C has been adopted. The French State uses 2 steels of this kind: the first known as Ac54 has a strength of 54-64 kg./mm.^{2} with an elongation of more than 20%, the second known as Ac50 possesses a strength within the range 50-57 kg./mm.^{2} with an elongation of more than 22% (on 100 mm.). Cr-Cu steel is now commonly used in bridge and similar construction examples of which are described and illustrated. FR (11b)

Phosphorus in Rolls Cast in Chill Molds (Der Phosphor in Kokillenhartgusswalzen). H. Rudolph. *Mitteilungen aus den Forschungsanstalten des GHH-Konzerns,* Vol. 3, Apr. 1935, pages 208-222. The effect of P in hard rolls cast in chill molds was investigated. Three zones can be distinguished in each of which P appears in a different phase. At the surface of the rolls, in the marginal zone of purely white Fe, P occurs in form of a "pseudo-binary" eutectic Fe-Fe_3P-graphite, a phosphide ternary solid solution which has a very fine grain and is fairly regularly arranged in the radially oriented ledeburite. It cannot, or only very imperfectly, be made visible by the usual etching methods even under extremely high magnifications. The adjoining white, coarse grained ledeburitic zones show P as ternary eutectic, a phosphide-cementite-ternary solid solution which can easily be recognized and resembles the phosphide eutectic found in white, P containing types of pig Fe. In the third zone which is the whole gray zone beginning at the first few gray points down to the innermost graphitic-pearlitic core of the rolls, P crystallizes in independent islets of ternary phosphide eutectic which increase in size towards the center, and is found always at those places of the gray Fe where a change from the stable to the metastable system had taken place during solidification. A "pseudo-binary" eutectic could not be observed in the slowly solidifying gray core of the roll. The quality of the surface of such rolls is not harmfully affected by the phosphide eutectic. 13 references. Ha (11b)

Physical Properties of Iron-Aluminum Alloys. C. Sykes & J. W. Bampfylde. *Foundry Trade Journal,* Vol. 51, Sept. 20, 1934, pages 181-183; *Iron & Steel Industry,* Vol. 8, Oct. 1934, page 22. Abstract of paper presented at the Iron & Steel Institute meeting in Belgium. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 582. CMS (11b)

Magnetic Properties of Iron as Affected by Carbon, Oxygen and Grain-Size. T. D. Yensen & N. A. Ziegler. *Transactions American Society for Metals,* Vol. 23, June 1935, pages 556-576. 7 references. Presents data in tabular and graphic form showing relation of magnetic properties of Fe to the C and O contents and grain size and ties the data to results published in 1924. It is shown that effect of O on magnetic properties is very great up to about 0.02% and inappreciable above that to 0.15%, the limit investigated. Magnetic data suggest a solid solubility of O in Fe of 0.02% but other data suggest 0.01% and the point needs confirmation. Effect of C is less than previously thought, some of the effect previously attributed to it is found due to O. Grain-size effect appears to be proportional to the grain number. WLC (11b)

Mechanical Properties and Abrasion Resistivity of Various Pearlite Cast Irons. Sansaku Miura. *Tetsu-to-Hagane,* Vol. 21, Feb. 25, 1935, pages 63-67. Mechanical properties of 5 kinds of Cr cast irons (total C 3.2%, combined C 0.7%, Cr 0.2 — 1%, Mn 0.6 — 0.9, Si 1.7 — 2.4 %) and 7 kinds of typical plain pearlite cast irons (total C 2.2—3.2%, combined C 0.75%, Mn 0.7 — 2.2%, Si 0.8 — 2.9%) were measured and compared with one another. Tensile strength of Cr cast irons increases with increasing Cr, and at 1% Cr reaches 33.5 kg./mm^2. The strength of the all plain pearlite cast irons tested was higher than this value. Brinell hardness and transverse strength increase with increasing Cr, while the deflection and the drop test values decrease somewhat as Cr content increases. Using a specially devised abrasion tester, the weight losses of specimens due to abrasion were measured under the following conditions; applied load 2 and 5 kgs, circumferential speed of specimens 2.2, 4.5 and 9.0 m./sec, total revolutions of specimens 2000. The weight losses of the Cr cast irons decrease as Cr content increases, being always smaller than those obtained with the plain pearlite cast irons. Coefficient of friction at low speed is smaller than at high speed, and the weight loss due to abrasion increases with the applied load, though it is not proportional to the work done. TS (11b)

Review of the Development and the Present Status of Structural Steels Employed in Automobile Design (Ueberblick über die Entwicklung und den augenblicklichen Stand der in der Automobiltechnik zur Verwendung kommenden Baustähle). Fr. Brühl. *Automobiltechnische Zeitschrift,* Vol. 38, June 25, 1935, pages 314-316. The automobile industry needs steels which possess good hardenability, high wear resistance and toughness, with a high ratio of elastic limit to ultimate strength. Crankshafts are made now not of high alloy Cr-Ni steels but preferably of the following composition:

	C	Si	Mn	Cr	Mo
Steel I	0.45	0.25	0.80	—	—
Steel II	0.35	0.30	1.30	—	—
Steel III	0.35	0.25	0.80	1.0	0.20

In the hardened state they have a tensile strength of 80-90 kg./mm.^{2}. Steel II has an especially high wear resistance. They are mostly hardened locally at the bearing places. Springs are made of steels of the following compositions:

	%C	%Mn	%Si	%Cr	%V	tensile str. kg./mm.^{2}	elas. lim. kg./mm.^{2}
Steel 1	0.6	1.8	—	—	—	130/150	120/135
Steel 2	0.5 0.7	0.8	1.8	—	—	130/150	120/135
Steel 3	0.5	0.8	—	1.0	0.15	140/150	125/135

Valve springs must have a particularly high strength for torsional vibrations. They are made of drawn music wire with 0.65% C, and are coiled in cold state. Valves are made of steel with 0.45% C, 2.75% Si, 0.40% Mn, 9% Cr. They are non-scaling up to 700°-800° C. and have about 90 kg./mm.^{2} ultimate strength with 60 kg./mm.^{2} elastic limit. The valve shaft is made of a steel with 0.5% C, 1.8% Si, 0.75% Mn, 13% Ni, 15% Cr, 2.25% W, with 80 and 45 kg./mm.^{2} respectively. This steel has proved very satisfactory under high stresses at high temperatures. Ha (11b)

Alloy Cast Irons. J. E. Hurst. *Metallurgia,* Vol. 12, May 1935, pages 15-18. Describes alloy irons that have been used and discusses their properties. Alloying elements discussed are Si, Ni, Cr, Mo, Cu and Al. JLG (11b)

Properties of Some Cast Alloy Steels. T. N. Armstrong. *Transactions American Society for Metals,* Vol. 23, Mar. 1935, pages 286-318. Reports study of mechanical properties of 26 cast steels of low alloy content of Mn, Si, Ni, V, Cr, Mo, Cu and Ti in various combinations and with C 0.10%-0.38%. Tests were made in as cast condition and after 9 different treatments involving no liquid quenching. In addition certain steels are reported in water quenched and drawn condition. The author concludes from his data that excellent mechanical properties can be obtained with low alloy steel of Mn 1.00% or over that rapid cooling through the critical range is necessary to eliminate dendritic structures which return on reheating to within the critical range, that normalizing results in finer grain and better dispersion of constitutents than annealing and that double normalizing improves the quality of obtained from single normalizing. In all except lowest C and alloy steels, tempering after normalizing produces good ductility. Cu with small amounts of other alloys gives excellent properties particularly as to ductility. Highest strength for amount of alloy is obtained from 1.5%-2.0% Ni, 0.85%-1.5% Mn and 0.11%-0.16% V and addition of 0.33% Mo to this composition results in highest impact resistance. WLC (11b)

Structure and Formation of Lamellar Pearlite (Sur la structure et la genèse de la perlite lamellaire). N. T. Belaiew. *Revue de Métallurgie,* Vol. 32, Apr. 1935, pages 145-155. In a 0.90% C steel, ferrite occupies a predominant position because it is 6.23 times more abundant than cementite and its response to heating is about 4 times as pronounced as that of cementite. This can be seen from the solubility curves for both substances in the equilibrium diagram. Ferrite imposes its crystalline characteristics on cementite. It is composed of individual cubes which can be brought out by etching with weak acids and which measure about 250 milli-microns on the side. The distance between cementitic lamellae in a given grain of pearlite cooled with a normal speed is usually between 300 and 350 milli-microns. In troostite it drops to 100 milli-microns and in very slowly cooled pearlites rises several times above 350. There is apparently a definite simple relation between this distance and the diameter of the grain containing it. Many observations and measurements suggest 1:100 ratio. Its true value depends on the stereographic orientation of the crystals observed. Crystalline character of cementite is clearly tabular. Crystallization of pearlite takes place grain by grain, and not by precipitation of individual cementitic lamellae. The linear crystallization velocity of cementite is great. Its lamellae are located parallel to the direction of crystallization reaching from one side of a grain to the opposite. In the process of crystallization C atoms travel across ferritic lattice to the cementitic films in the process of forming. Bain showed that for formation of pearlite a speed of cooling less than 100° C./min. is required. For the precipitation of a phase a certain undercooling is required. Assuming it to be 20° C., one can see that the speed of diffusion necessary for formation of normal pearlite is of the order of 0.2 sec. This value checks well with the results of motion pictures taken under the microscope. When the diffusion speed of C greatly exceeds the values necessary for the formation of the usual lamellar grains, abnormal steel associated with quenching difficulties is formed. JDG (11b)

Specifying Steel Castings for Exacting Service. *Machine Design,* Vol. 7, Apr. 1935, pages 23-25. Discusses the statements of Connarroe at the recent meeting on "Engineering Uses of Modern Cast Metals" jointly sponsored by 3 Engineering Societies at Chicago. The effect of V, Mn, Cr, Mo, W and Ni on steel is considered at length. Diagrams and tables are presented illustrating the physical property changes due to thermal treatment and analysis. Cast alloy steels normalized and drawn at 1250° F. show the following physical properties:

	C	Mn	Si	Ni	V	Mo	Cr	tensile strength	yield point	elongation	reduction of area
Ni-V	.26	.97	.30	1.54	.11	—	—	90.000	60.000	25.5	50.9
Ni-Mn	.32	1.10	.31	1.37	—	—	—	91.400	63.250	25	40.0
Ni-Mo	.33	.70	—	1.37	—	.33	—	91.045	60.536	24.8	54.9
Mn-Mo	.35	1.35	—	—	—	.35	—	96.000	68.000	25.5	51.5
Ni-Cr	.35	.80	.40	1.30	—	—	.94	102.000	67.400	21.0	41.0
Cr-Mo	.39	.81	—	—	—	.43	.69	103.000	73.000	19.0	40.0
Ni-Cr-Mo	.35	.85	—	1.75	—	.35	.75	118.000	90.000	18.0	35.1
Mn-Cr-Ni-Mo	.34	1.58	—	1.22	—	.32	.71	125.000	92.000	22.7	51.2

WH (11b)

Comparative Investigation of Copper-, Aluminum-, and Manganese-bearing Zinc Base Alloys with Electrolytic Zinc as Well as Refined Spelter as the Base Metal (Vergleichende Untersuchungen an kupfer-, aluminium-, und manganhaltigen Zink-Basislegierungen mit Elektrolyt-Zink bzw. Raffinade-Zink als Grundmetall). W. Guertler, F. Klewetz, W. Claus & E. Rickertsen. *Zeitschrift für Metallkunde,* Vol. 27, Jan. 1935, pages 1-10. Zn base alloys made from both electrolytic Zn (99.98%) and spelter (98.86% Zn) and containing Al:Cu:Mn in the following percentages: (1) 0:2:0, (2) 2:2:0, (3) 0.5:4:0, (4) 2:4:0, (5) 2:4:1, (6) 4:2:0, (7) 4:3:0, (8) 4:4:0, (9) 2:6:0, (10) 2:8:0, were tested in the sand-cast, chill-cast and rolled conditions. All of the alloys were found to cast well, numbers 1-5 being superior in this respect. Cast specimens were subjected to tests of impact-bending, tensile strength, elongation and Brinell hardness. Alloys made from electrolytic Zn were found to be superior to those made from spelter in the first three tests, with no consistent difference in the hardness. Chill-cast alloys gave higher values than the sand-cast alloys in the first three tests, but were similar in their hardness. Rolled specimens were subjected to tests of tensile strength, elongation, Brinell hardness, repeated bending, and deep drawing. The tensile strength of the rolled alloys made from electrolytic Zn was generally slightly lower than that of the spelter alloys while the elongation was much higher. Rolled alloys made from spelter were found to be slightly harder. The response of all of the alloys to the repeated bending and deep drawing tests was found to be poorer than that of the unalloyed Zn. In addition corrosion tests were carried out on all of the alloys. Cast alloys of electrolytic Zn subjected to moist air at 95°-100° C. for 24 hrs. were found to be more resistant to corrosion as judged by their response to the impact bending test subsequent to exposure. Of the rolled alloys, only those made from electrolytic Zn were tested in corrosion. After 24 hrs. of exposure to moist air at 95°-100° C. all rolled specimens were found to have suffered slight losses in their tensile strength and a loss of 50% or more of their elongation. Corrosion by intermittent immersion in water solutions of: (a) 3% NaCl + CO_2, (b) 3% NaCl + 0.5% H_2O_2, (c) 3% NaCl + 0.5% H_2O_2 + CO_2 was also carried out on rolled specimens. The corrosion by solutions (b) and (c) was about 10 times as severe as that by solution (a), as judged by measurements of the loss in weight of the specimens. Resistance to this type of corrosion appeared in all alloys after 4 days in solution (a) and after 2 days in solution (b) and (c). A description of all tests is given and a complete tabulation of all results is presented in 28 tables and diagrams. FNR (11b)

Influence of Vanadium on Carbon Steel and on Steels Containing Nickel and Chromium. H. H. Abram. *Iron & Steel Industry,* Vol. 8, Oct. 1934, pages 23-24. Abstract of paper presented at Iron & Steel Institute meeting in Belgium. See *Metals & Alloys,* Vol. 6, May 1935, page MA 208L/2. CEJ (11b)

Yield Point Is Paramount. D. P. Forbes. *Machine Design,* Vol. 7, May 1935, pages 24-25. Deals with malleabilizing of white iron castings. Malleable Fe is unusual in that the yield point is a high percentage (about 67%) of the ultimate strength. Low C malleable Fe shows as high as 25% elongation. The commercial applications particularly in railroad work and agricultural fields are discussed. WH (11b)

Vibration Strength and Damping Capacity of Unalloyed Steels as Dependent on Chemical Composition and Heat Treatment (Schwingungsfestigkeit und Dämpfungsfähigkeit unlegierter Stähle in Abhängigkeit von der chemischen Zusammensetzung und der Wärmebehandlung). M. Hempel & C. H. Plock. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf,* Vol. 17, No. 2, 1935, pages 19-31. Damping capacity of a material is defined as its ability to convert the energy imparted to the material by vibrations into heat. It was investigated in what manner in some C steels damping capacity changes with varying contents of Si and Mn, and what influence frequency and amplitude of vibrations exert. The method of testing is described. The general conclusions are that the highest values of vibration strength were found at the pearlite point in C steels, but no relation could be established between magnitude of damping and C content. An increase of Si seems to decrease and an increase of Mn to increase vibration strength somewhat; the small number of experiments did not permit absolutely conclusive results. Different kinds of heat treatment seemed to point to a relation between damping and vibration strength inasmuch as a structure of high vibration strength possesses a higher damping capacity; damping always decreases with the time during which load is applied. A determination of vibration strength from statically determined mechanical properties is not possible, endurance tests have to be made for it. 20 references. Ha (11b)

Alloy Steels: Their Properties and Manufacture. W. H. Hatfield. *Iron & Steel Industry,* Vol. 8, Feb. 1935, pages 183-186, 192. For every purpose there exists an alloy steel of such an analysis and heat treatment as will enable it to be employed more economically and to give better service than carbon steels. A table gives compositions, heat treatment, and mechanical properties for 31 typical alloy steels. The text discusses briefly the properties of these alloys. CEJ (11b)

12. EFFECT OF TEMPERATURE ON METALS AND ALLOYS

L. JORDAN, SECTION EDITOR

The abstracts in this section are prepared in co-operation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M.

Creep Resistance of Chromium-Tungsten Steels (Warmfestigkeit von Chrom-Wolfram Stählen). K. Adloff. *Die Wärme,* Vol. 58, Mar. 16, 1935, pages 180-181. W is said to check the tendency of grain growth in heat resistant steels. Plain C steels are useful up to 375° and Cr steels up to 480°C. The latter, however, show grain growth. Between 480°-650°C., 18/8 is subject to intercrystalline embrittlement. A 0.1-0.25% C, 0.55% Mn, 0.5% Si, 4.5-6.5% Cr and 0.75-1.0% W steel has valuable properties. It has the same thermal expansion coefficient as plain C steel but the ratio of creep resistance is 100 : 1. BF (12)

Contribution on Determination of Creep Strength (Ein Beitrag zur Bestimmung der Dauerstandfestigkeit). W. Ruttmann & R. Mailänder. *Technische Mitteilungen Krupp,* Vol. 2, Dec. 1934, pages 152-159. It is not feasible to predict the long time behavior of metals in the creep test by short time tests. If the material is stable at the test temperature, short time tests have practical value. The authors are hopeful for considerable progress in this field. MG (12)

Creep Properties of Oil-Still Tubes. Howard C. Cross & E. R. Johnson. *Iron Age,* Vol. 134, Aug. 23, 1934, pages 16-21, 68. See "Creep Properties of 5 per cent Chromium, 0.50 per cent Molybdenum Steel Still Tubes," *Metals & Alloys,* Vol. 6, May 1935, page MA 209L/8. VSP (12)

Thermal Expansion Characteristics of Some Nickel Cast Irons. T. J. Wood. *Transactions American Society for Metals,* Vol. 23, June 1935, pages 455-468. Reports the thermal expansion properties of cast irons ranging from 0-70% Ni. Low alloy or ferritic irons on account of their low resistance to heat and corrosion are applicable only to low temperatures and mild conditions. White iron of 4.5% Ni, 1.5% Cr is however an exception as it has high heat resistance. With 18-22% Ni (or Monel) high expansion characteristics are obtained and to get comparable heat and corrosion resistance with low expansivity 27-45% Ni must be used. Lowest expansion rates were found for 34-35% Ni. Substitution of Ni + Cu in the Monel ratio for equivalent amounts of Ni produces comparable expansion rates to straight Ni irons of 15-20% but at higher ranges the Ni-Cu alloys have higher expansivities than Cu-free cast irons. WLC (12)

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13. CORROSION AND WEAR

V. V. KENDALL, SECTION EDITOR

Metallic Coatings as Protective Media. S. Robson & P. S. Lewis. *Journal Society of Chemical Industry,* Vol. 54, June 28, 1935, pages 605-616. The physical and chemical properties of metallic coatings of Zn, Al, Sn, Pb, Cd and Ni are presented in considerable detail, forming an engineering guide for the proper selection of plant construction material. The chief characteristics of Zn are: (1) It readily alloys with Fe, C steel, Cu or brass forming firmly adhering coatings. (2) The intermetallic compounds formed with Fe ($FeZn_3$, $FeZn_7$, $FeZn_{10}$) are hard and brittle, resisting wear but not excessive deformation. (3) Zn is attacked by most acids with the formation of Zn salts, and should never be used where the purity of a product would be contaminated. (4) Zn withstands acetylene, anhydrous alcohol, dry Cl, formaldehyde, HCN and other given compounds. (5) Zn affords corrosion protection by sacrificial and electrochemical action. (6) An oxidized Zn coating gives the best surface for painting. (7) No appreciable difference appears to exist in the corrosion resistance of Zn applied by either galvanizing or sherardizing. The characteristics of Al are: (1) Highly resistant to organic acids and inorganic acids, except HCl and HF. (2) Fully resistant to S, H_2S and organic S compounds. (3) Highly resistant to atmospheric corrosion, protection being afforded by a protective oxide. (4) Reaction products in cooking are negligible and non-toxic. (5) Al is unsuitable for alkalis. The characteristics of Sn are: (1) Highly resistant to many fruit and vegetable acids, chief reason for its wide use in the canning industry. (2) Withstands severe deformation without rupture. (3) Sparingly used in chemical engineering, due to its chemical activity in inorganic acids, bases and salts. Characteristics of Pb are: (1) Fully resistant to H_2SO_4, SO_2 and SO_3. (2) HNO_3 attack decreases with increased acid concentration, a protective film forming at 70% or over. (3) Unsuitable for HCl, NaOH or KOH. Characteristics of Cd are: (1) Sacrificial protection to Fe and Cu. (2) Less resistant than Zn to oxygen attack, moist acid, ordinary atmospheric or saline atmospheric corrosion. (3) Does not bond to Fe or C steel as well as Zn. Ni is characterized by: (1) The metal's inherent inactivity in HCl and H_2SO_4, being only slightly soluble in these acids. (2) The remarkable resistance to alkalis, even in their fused state. (3) Its high activity in contact with HNO_3. The various metal coating processes, their advantages and disadvantages, and physical properties are discussed in detail. AAA (13)

Corrosion Resistance of Metals in Corn Processing. F. L. LaQue. *Canning Age,* Vol. 16, July 1935, pages 315-317, 332. A study of the corrodibility of various metals as determined by weight loss was made by exposing 2¼" diam. disc metal sheet specimens in a spool type holder under actual canning plant operating conditions. Pure Ni, Sn, cast bronze and 50-50 solder were unaffected in the corn silker; Monel metal, yellow brass 18% Ni silver, Cu and Zn were tarnished somewhat. Pure Ni, only, was unaffected in the brine tanks although Monel and Sn showed good corrosion resistance. In the corn mixer, Sn, solder and Zn were most resistant. The taste of canned corn, inoculated respectively with up to 80 parts/million of Cr, Cu, Fe, Ni, Sn and Zn chlorides, was unaffected but Cu and Fe discolored the product; Ni, Sn and Zn had no important effect. BWG (13)

Corrosion Resistance Tests of Metals Used in Tomato Products Processing. F. L. LaQue. *Canning Age,* Vol. 16, July 1935, pages 363-366. Tests on equipment used in processing tomato juice and catsup were made by using same general methods as in the study on metal corrosion in corn processing (see previous abstract). Of the metals tested, Al, Cu, Ni, Sn, bronze and Monel, Al showed least weight loss in hot extracted tomato juice and in the filling machine bowl; Monel metal was attacked least in the catsup boiling kettle and finisher as well as in the tomato scalding tank. In general Monel, Ni and Al were most corrosion resistant. By adding known concentrations of citrates of Al, Cr, Cu, Fe, Ni, Sn and Zn and examining contents after 6 months storage it was found that copper was the only metal causing noticeable effect on flavor and color (brownish cast above 16 p.p.m. Cu). BWG (13)

Corrosion of Metal Combinations and Its Prevention (Korrosion an Metallkombinationen und ihre Verhütung). Erich K. O. Schmidt. *Metallwirtschaft,* Vol. 14, May 24, 1935, pages 409-412. When 2 dissimilar metals in contact with each other are immersed in or in contact with an electrolyte, electrolytic corrosion takes place. The metal with lower potential corrodes much faster than it would if it were not in contact with the other metal. This fact is made use of in the protection of steel by Zn and Cd plating and of high strength Al alloys by covering them with a thin layer of pure Al. The Zn, Cd, and pure Al corrode and the steel and Al alloy remain unattacked. It is not always possible to prevent undesirable electrolytic corrosion by using only one metal. In some cases one of the metals can be covered with a coating of the other or both metals coated with a third. For instance, Al alloys and heavy metals in contact can be covered with or separated by a thin sheet of Cd. In other cases it is possible to eliminate the electrolyte by drying the air or gas in contact with the metals. A third method of preventing electrolytic corrosion is the use of insulating coatings, washers, or other parts, made of wood, cement, rubber, bakelite, or asbestos, between the 2 metals. 11 references. CEM (13)

Internal Corrosion of Natural Gas Transmission Lines. Elmer F. Schmidt & Thomas S. Bacon. *Gas Age Record,* Vol. 74, Dec. 15, 1934, pages 531-534, 536; *American Gas Journal,* Vol. 142, Jan. 1935, pages 26-28, 33. Paper presented before the American Gas Association, Oct. 1934. See *Metals & Alloys,* Vol. 6, May 1935, page MA 211L/3. VVK + CBJ (13)

Reducing Abrasion by Compound Contact Pieces. S. Saito & N. Yamamoto. *Metal Progress,* Vol. 27, June 1935, pages 52-55. Describes experiments with different materials in brakes and combinations of different materials as brakes on the same surface. From the results it is concluded that to reduce the wear between 2 ductile materials, as steel tire and steel brake shoe, a third element, second brake shoe, must be of a brittle material whose wear results in fine particles whose hardness is less than the other members. If the particles have the property of preventing oxidation their effectiveness in wear reduction is increased. Combinations discussed are steel tire with steel brake and cast iron brake, and Cu trolley with Cu contact and hard rubber member. WLC (13)

Cylinder Wear in Explosion Motors and Its Prevention (Zylinderverschleiss in Verbrennungsmotoren und seine Verhütung). B. von Lengerke. *Automobiltechnische Zeitschrift,* Vol. 38, May 25, 1935, page 264. The advantages of addition of graphite in colloidal form to the lubricating oil for cylinders are discussed. A real protection can, however, be exerted only if a continuous film of graphite is formed on the surface. The conditions necessary for it are explained. Ha (13)

Prevention of Corrosion in Gas Condensers. J. A. Korany & E. M. Bliss. *Gas Age Record,* Vol. 75, Jan. 12, 1935, pages 33-34. Paper presented at meeting of the Metropolitan Gas Chemists' Council, N. Y., Nov. 15, 1934. Corrosion of the cast Fe jacks in contact with Admiralty bronze tubes in 4 large condensers caused by the salt content of the water was corrected by the installation of the Kirkaldy system in which the entire condenser is made cathodic to iron anodes under a constant difference of potential of .3 to .5 volt. Due to the variation in salt content a constant current regulator was also installed. Installation of Zn plates had been found ineffective. The life of the Fe anodes will be about 3 years. VVK (13)

New Instrument for Determination of Corrosive Currents in Pipe Lines and Cables (Ein neues Gerät zur Messung von Korrosionsströmen in Rohrleitungen und Kabelmänteln). K. Rottsieper. *Elektrizitätswirtschaft,* Vol. 34, Apr. 5, 1935, pages 230-232. The former electrical apparatus designed for the determination of galvanic currents in cables required the removal of part of the insulation. A new equipment is introduced which is based on the tranformer principle which eliminates contact with pipe or cable. When a cable carrying a 3-phase current is inspected, measurements can even be made during operation. Principle, wiring and operation of the author's apparatus developed in the Allgemeine Elektrizitäts Gesellschaft are discussed in full detail and shown in 5 illustrations. Intensity as well as direction of current is measured with the new instrument. WH (13)

Even Impure Iron Does Not Oxidize in Pure or Saturated Moist Air (Le Fer, même impur, ne s'oxyde pas à l'air pur et humide à saturation). Paul Ronceray. *Bulletin de la société chimique de France,* Vol. 5, Mar. 1935, pages 742-745. It is shown that microscopic contaminations represent an essential factor in the corrosion of Fe at ordinary temperatures in air whether pure or saturated with moisture. With these inclusions absent, Fe preserves its property of resisting oxidation under the above conditions even if chemically impure. The local element theory does not fully account for the formation of rust in pure or moist atmospheres. Although still obscure, the role of pits and depressions in the development of rust is connected with the presence of inclusions at these locations and consequently with the formation of rust. EF (13)

Rate of Formation and Electric Conductivity of β-Silver Sulphide. A Contribution to the Knowledge of the Tarnishing Process (Bildungsgeschwindigkeit und elektrische Leitfähigkeit des β-Schwefelsilbers. Ein Beitrag zur Kenntnis des Anlaufvorganges). H. Reinhold & Hans Möhring. *Zeitschrift für physikalische Chemie,* Abt. B, Vol. 28, Mar. 1935, pages 178-188. Results of measurements of the rate of formation and electric conductivity of β-Ag_2S are in fairly good agreement with the values postulated by C. Wagner's theory of the tarnishing process (*Zeitschrift für physikalische Chemie,* Ser. B, Vol. 21, 1933, pages 25, 42) according to which the rate of tarnishing, i.e., the rate of formation of a metal compound from its elements is a function of the electric (electrolytic and electronic) conductivity of the compound formed. The rate of tarnishing of Ag defined as the time required for complete sulphurization of a Ag wire of known dimensions immersed into molten S, to β-Ag_2S is determined between 130° and 170°C. by the tarnishing constant $k = 17.e^{-10,500/T}$. ORS (13)

Protective Coatings for Pipe Lines. Kenneth Shibley. *Journal American Water Works Association,* Vol. 26, July 1934, pages 891-901. An exposition of the use of cement mortar for exterior and interior protection for pipe lines. VVK (13)

Condenser Tubes (Les Tubes de Condenseur). L. Guillet. *Cuivre et Laiton,* Vol. 8, June 30, 1935, pages 283-284. The advantages of condenser tubes of Cu and brass, especially where sea water is used, are discussed. Brass tubes are made usually of 72-67% Cu and 28-33% Zn. They have a very good corrosion resistance. Sometimes dezincification occurs whereby at certain places Cu in powdery form accumulates. No certain cure for it has yet been found. Tubes of cupro-nickels, Cu 70%, Ni 30%, of Al bronzes with 10% Al, or bronzes of Cu-Sn with maximum 5% Sn have been used with more or less success depending on composition and temperature of the sea water. Ha (13)

Ocean Transportation of Petroleum in Bulk. Part 2. Robert F. Hand. *Marine News,* Vol. 22, June 1935, pages 21-25. Discussion of safety precautions when tanker is under repair. Butterworth system of tank cleaning with water sprays at 175°F., and corrosion due to sea-water ballast. Corrosion of special steels in this service is stated to be as rapid as plain steels and tank coatings have been generally ineffective. The possibility is advanced of retarding corrosion inside the tank by the use of inert gas, N_2 which is believed to make possible the elimination of acid corrosion due to CO_2 dissolved in the sea-water used as ballast. The average rate of corrosion in vessels transporting sweet crudes is about 1/200" and for sour crudes it is about 1.5/200" penetration per year. Over a period of 20 years the total corrosion approximates 2-3% of the original thickness. The more corrosive service is in the transportation of gasoline and kindred products which tend toward an average rate of corrosion of about 1/16" penetration per year between the 4th and 5th years with very little corrosion occurring in the 1st year and the rate increasing progressively each year. WB (13)

Cathodic Protection of Pipe Lines from Soil Corrosion. Scott Ewing. *Natural Gas,* Vol. 16, Mar. 1935, pages 5-10; Apr. 1935, pages 16-20. Cathodic protection is in many cases a reliable means for effectively reducing or even entirely stopping the corrosion of underground pipe lines. Whether it is economical to use cathodic protection or any pipe system depends upon its cost and the savings over other protective methods. The cost of the cathodic protection depends primarily upon the condition of the coating on the pipe line. If the pipe line is bare, or is an old one, on which paints or other inadequate coatings were used, the cost of cathodic protection would be large. Whether a system of cathodic protection is economical in such cases will depend on many considerations and cannot be answered in general. Some engineers believe that it may be feasible to use cathodic protection on some bare lines. The use of cathodic protection will be extended to many lines as more experience and skill are required in the design and operation of cathodic protection circuits. A new line can be built so that cathodic protection could be applied to it with very little expense at any future time. The most extensive use so far has been on lines that have begun to develop leaks and that are coated with reasonably high resistance coatings. Methods are described for making preliminary surveys for estimating costs and for determining where drainage stations should be located. Methods are also given for determining whether or not the protection is effective at any time the installation is in operation. WH (13)

Failures of Machine Parts Show Needed Design. Franklin L. Everett. *Machine Design,* Vol. 7, Apr. 1935, pages 33-35. Urges that no machine which has failed in service should be thrown out without fully determining the cause of failure. An analysis of failure and recommendations for proper design are made on the basis of considering the type of stress condition and form of structure with reference to separator teeth, valves, shaft with woodruff keyway, crankshaft, bolts and nuts, connecting rod, torsion spring, shrink-fit collar. 8 illustrations. WH (13)

Underground Corrosion. K. H. Logan. *Proceedings American Society of Civil Engineers,* Vol. 61, Mar. 1935, pages 317-331. Underground pipes in the U. S. have been estimated to have a length of 450,000 miles and a value of nearly $6,000,000,000. The annual loss due to underground corrosion of pipe lines in the oil industry alone has been estimated at $25,000,000. Soil corrosion is characterized by the uneven distribution of the corrosion and the fact that most ferrous pipe materials corrode at nearly the same rates. The major cause of the corrosion seems to be non-uniformity in the distribution of oxygen and moisture along the surface of the pipe line. Among the methods suggested for reducing corrosion losses are the use of Cu and Cu-alloy pipe which corrode less rapidly than ferrous materials; increasing the thickness of the pipe walls; and the use of protective coatings. Soil corrosivity surveys are suggested as a means for determining the need for protective coatings. Some of the weaknesses of coatings are noted and cathodic protection is suggested as a means of improving the effectiveness of coatings. 26 references. VVK (13)

Practical Rust Protection (Praktischer Rostschutz). Julius Moshage. Max Jänecke Verlagsbuchhandlung, Leipzig, 1934. Paper, 6 x 8¼ inches, 95 pages. Price 4 RM.

After an introduction reviewing theoretical fundamentals, the author outlines the book as follows: I. Surface protection by metallic or non-metallic coatings, in which is taken up metallic coatings and their production, non-metallic coatings, such as paints, slushing oils and greases, cement ,and enamel; II. Surface protection by chemical alteration of the surface of the iron in which is discussed the formation of diffusion coatings, phosphate and nitriding processes, and the formation of color coatings; III. Protection by chemical or electrochemical action on the solution agency such as the treatment of feed water and the Cumberland process for protecting boilers; IV. Protection by alloying, stainless steel, rust-resistant cast iron and heat-resistant iron alloys. Few books attempt to cover as much ground in as little space. In justice to the author, it should be noted that he makes no pretensions to a comprehensive treatise, rather endeavoring to furnish practical information in as little space as possible. Naturally to cover as extensive a field as is attempted, the result is sketchy It is however, a good birdseye review of rust protection for the student. The section on alloys could have been improved by giving an adequate idea of the corrosion resistance and applications of the Cr and Cr-Ni alloys without attempting to cover the mechanical properties. The technical worker will receive little information that he does not already have V. V. Kendall (13)—B—

The Problem of Tar Still Corrosion. Part I. Introduction. J. C. Mann & D. W. Parkes. **Part II. Investigations on the Causes of Corrosion.** D. W. Parkes. **Part III. Prevention of Corrosion.** D. W. Parkes. *Journal Society Chemical Industry,* Vol. 53, Oct. 12, 1934, pages 847-851; Oct. 19, 1934, pages 864-868; Oct. 26, 1934, pages 907-912. An investigation by a committee of the Association of Tar Distillers working in conjunction with the Department of Scientific and Industrial Research. Part I contains works results and experiences. Part II and Part III are based on research both in the laboratory and the works. Ammonium chloride is primarily responsible for the corrosive action of tar but other factors could easily influence it. The introduction of NH_3 and H_2S is studied. Aside from gross overheating, direct heating of the metal does not greatly influence corrosion. From a study of the use of special irons and steels it is concluded that tar derived from vertical retorts worked with fairly heavy steaming is the most corrosive especially in the vapor phase which was attributed to its high Cl content coupled with its comparatively low Fe content, the Cl being mainly "volatile." Mild steel in the vapor phase is more heavily corroded than any other metal with the exception of Al-coated steel and an 18% Cr iron. The liquid corrosion is moderate. Ni shows a marked resistance to vapor corrosion and its influence can be traced in all its alloys. A critical amount of Ni seems to be necessary. The influence of Ni on liquid corrosion is not very marked but is of some value. Cr in conjunction with Fe alone appears to be of little value but with Ni confers increased resistance if the Ni content is high enough. C in iron and steel has no effect on corrosion. Cu alone is considerably more resistant to vapor phase corrosion than mild steel, but its resistance to liquid phase corrosion is poor. Si (2.75-3.25%) confers great resistance to liquid corrosion. Mn and Mo in the small quantities tested do not appear to have any marked effect. Al is more resistant to vapor corrosion than mild steel but in the liquid phase is violently attacked. The temperature is too high for Pb-coated steel to be of use. VVK (13)

Some Causes for the Failure of Lead and Lead Pipes and Suggested Remedies Ernest King & Kenneth Gray. *Journal & Record of Transaction of the Junior Institution of Engineers,* Vol. 45, Dec. 1934, pages 123-138 Paper delivered before the Institution, London, Oct. 1934, points out that some Pb pipes have remained sound for centuries; others failed in a year. Extrusion production is described. Mechanical failures are due to internal stresses caused by freezing of H_2O or uneven wall size. Concerning chemical corrosion, mortar was found to be a source of failure. Distilled water, free from dissolved O is without action on Pb. Water containing only dissolved O oxidizes Pb rapidly. Water containing O and CO_2, varying with the relative concentrations of the 2 gases, dissolves Pb in some combinations, but forms a protective coat in others. In natural waters, tap water if moderately hard has no effect on Pb, whereas soft tap water has a varying effect according to the degree of alkalinity. If the latter is 1.5-2.5 (expressed as parts of $CaCO_3$/100,000) irregular corrosion occurs, but if above 2.5 a protective film is formed. Bitumen sleeves or felt impregnated with bitumen afford protection where pipes pass through walls. Use of aluminous cement instead of Portland cement has the same effect. In contact with damp timber, corrosion takes place, especially in the case of oak and teak, while pitch pine, deal and elm are less aggressive in the order named. Organic acids from the timber together with moisture, O and CO_2 are to be blamed. The (less common) instances of corrosion in soil and pH determinations are discussed. Electrolytic corrosion due to stray currents is considered. Less reliance than formerly is placed on the presence of Pb peroxide as a positive indication of electrolytic action, which sometimes causes inter-crystalline attack. Galvanic action due to oxide or other inclusions leads to corrosion. British investigations on fatigue failure of Pb pipes are fully discussed and remedial measures given in each case considered. Failure through oxide inclusion is dealt with. Experiments of the authors established that no weakness in the weld could be detected when using oxide-free Pb with a bridge-die. Concludes with a metallographic study on some 2000 year old Roman Pb pipe recently found during the excavation of the Roman baths at Bath, England. Conclusions as to the making of Pb pipes by the ancient Romans are set forth. WH (13)

The Corrosion of Lead in Buildings. F. L. Brady. *Department of Scientific & Industrial Research, Building Research, Technical Paper* No. 8, 1934, 25 pages; *Analyst*, Vol. 60, May 1935, pages 321-323; *Engineering*, Vol. 139, June 21, 1935, page 656. Corrosion of Pb in buildings is due to contact with cement, timber or soil or to the effects of elastic fatigue accelerating decay. Cement is more corrosive than mortar due to the more rapid carbonation of lime mortar than of cement mortar. $Ca(HCO_3)_2$ has no action. Slaked lime caused rapid corrosion. Carbonated lime mortar affords protection against solution of the Pb. Gypsum and chalk do not prevent the corrosion, although gypsum will protect against corrosion by H_2O. Organic acids in wood attack Pb. Under moist conditions, oak rapidly corrodes Pb; soft woods are less corrosive. Most soils are innocuous. Bituminous coatings are the best preventive. LFM + AHE (13)

Developments in the Use of Copper Tubing for Gas Service. E. A. Munyan. *Gas Age Record,* Vol. 75, Jan. 19, 1935, pages 43-48. Experiences with installing Cu pipe and fittings for gas services have been very successful in Cincinnati and are recounted in detail. Laboratory soil corrosion tests gave a life of Cu of 12 times that of steel. By reducing the tensile strength from 61,000 to 45,000 lbs./in.^{2} the elongation was increased to 13% in 2" which aided materially in preventing sharp breaks under soil load conditions. VVK (13)

Corrosion in Idling Boilers Due to Oxygen Absorption (Korrosion an wassergefüllten Dampfkesseln durch Sauerstoffaufnahme). *Feuerungstechnik,* Vol. 22, Apr. 1934, page 49. Corrosion attack directly under the water line was noticed in idling boilers. It was found that the boiler water was richer in O near the surface. After 12 days of idling, an O content of 5 mg./l. was detected. As a remedial measure it is suggested to maintain a temperature of 100° C. If boilers are shut down longer than 14 days, the addition of caustic soda and occasional agitation by pumps is urged. Suspended superheaters should be filled with NH_3 (of 100 mm. H_2O pressure) since water cannot be removed entirely. Addition of tri-Na phosphate (150 mg./l.) together with caustic soda (50 mg./l.) eliminates foaming when starting the boiler anew. If a boiler preserves a light overpressure no air can leak in and cause corrosion. WH (13)

Corrosion Tests and Corrosion Protection of Aluminum (Korrosionsprüfung und -Abwehr bei Aluminium). *Metallwaren Industrie & Galvano-Technik,* Vol. 33, Feb. 15, 1935, pages 73-74. Considers corrosion of Al in general and protection by (1) hydrated oxides (2) plating with Zn and Cd or rolling-on of pure Al, (3) heavy metal oxide films. Preference is given to the latter method which has become generally known as the Jirotka process. EF (13)

Bitumen as Protection against Corrosion of Lead (Bitumen als Schutz gegen die Korrosion des Bleies). E. Belani. *Werkstoffe und Korrosion,* Vol. 10, June 25, 1935, pages 29-31. Corrosion of Pb can take place in 3 different forms: chemical corrosion, in air, in the ground or in brick or concrete, whereby Pb carbonate, Pb oxide and Pb hydroxide (all poisonous) are formed; electrical corrosion, by stray currents, whereby the electrolysis forms Pb chloride, Pb sulphate, Pb nitrate and peroxide; and auto-corrosion whereby intercrystalline changes of the Pb are caused by continuous vibrations or concussions; the Pb becomes brittle and develops cracks. The third form occurs in bridges, elevators, etc. In the Pb sheaths of cables bitumen offers an excellent protection against chemical and electrical corrosion but the material should be free from tar. A number of bitumen products, their preparation, solvents for them, and methods of applying are discussed. Ha (13)

Corrosion Experiments with Screws in Light Metal Structures (Korrosionsversuche mit Schrauben in Leichtmetall-Bauteilen). H. Bauermeister & R. Kersten. *Zeitschrift Verein deutscher Ingenieure,* Vol. 79, June 15, 1935, pages 753-756. Tests of screw-joints of which the nut consisted of a light metal alloy showed that on account of the low potential difference between bolt and nut, the least corrosion occurs when the bolt is made of Al alloys. It is recommended to treat the bolts, and especially the nuts, with the Eloxal process as this prevents not only corrosion but also "freezing" between the parts. When using steel or brass screws in light metal structures, Zn washers are recommended as they reduce corrosion of the nut. Ha (13)

Alloys to Resist Corrosive Action of Combustion Products of Ethyl Gasoline. E. G. Brink. *Rensselaer Polytechnic Institute, Thesis,* June 1934, 30 pages. Fe alloys with 10 and 20% Cr with Al from 0 to 3% were coated with Pb bromide, or Pb sulphide and treated at high temperatures in oxidizing (air) or reducing (hydrogen) atmospheres. Ni-Mn alloys containing up to 4.5% Mn, and Ni-Cr alloys containing up to 10% Cr were given similar treatment. In Pb bromide, under oxidizing conditions, all combinations of Fe-Cr-Al were corroded, the least corrosion occurring in alloys with 3% Al. Under the same conditions, Ni-Mn alloys were not attacked, while Ni-Cr alloys showed a slight corrosion. In Pb bromide under reducing conditions, Fe-Cr-Al alloys were not attacked; Ni-Mn alloys were corroded, and Ni-Cr alloys corroded slightly. In Pb sulphide under oxidizing conditions, Fe-Cr-Al alloys suffered no corrosion; Ni-Mn alloys were corroded, while Ni-Cr alloys were only slightly attacked. In Pb sulphide, under reducing conditions, Fe-Cr-Al alloys up to 2% Al were unattacked, but with 3% Al corrosion was evident. Ni-Mn and Ni-Cr alloys were badly corroded. No alloy was found to resist both Pb bromide and Pb sulphide under oxidizing and reducing conditions. HWG (13)

Fissure Corrosion of Ferro-Nickels in Steam and Metals for Turbine Blades (La corrosion fissurante dans ferronickels dans la vapeur et les métaux d'ailettage pour turbine). P. Chevenard. *Aciers Speciaux, métaux et alliages,* Vol. 9, Oct. 1934, pages 340-348. The corrosion cracks (fissures) extend around the grains towards the interior of the material (22% Ni, 2% Cr), whereas the intercrystalline corrosion is propagated near the surface and is more common in 18-8 steels. Actually a corrosion crack is an intercrystalline corrosion due to mechanical strains of internal or external origin. Corrosion tests on a steel (0.65% C, 0.93% Mn, 22.3% Ni, 2.25% Cr) show that an increase in C content increases the corrosion at 155° C. in saturated steam at 5.4 atmosphere pressure. Cold worked material is quite susceptible to fissure corrosion. Thermomagnetic study of heterogeneous solid solutions such as of a metal containing 0.33% C, 0.09% Si, 1.50% Mn, 36.3% Ni, 11.0% Cr to some extent helps to reveal the extent of intercrystalline corrosion, mainly explained by the process of carbide formation. New high alloy steels containing Ni, Cr, Al, Ti, and Mo are immune to intercrystalline corrosion. GTM (13)

Corrosion below Discontinuous Oxide Coatings, with Special Reference to Magnesium. K. G. Lewis & U. R. Evans. *Journal Institute of Metals,* Vol. 57, May 1935, pages 221-238 (Advance Copy No. 702). Protective processes may be divided into a safe class and a dangerous class. In the former even incomplete covering gives more protection than no treatment while in the latter incomplete covering may cause more intense corrosion than no covering. Using a self-circulating apparatus, time-corrosion curves were obtained for untreated Mg in NaCl solutions and for Mg treated in 3 different baths, 2 used previously by Sutton and Le Brocq, and a new bath containing $ZnSO_4$ and NH_4NO_3. The influence of time in treating bath on rate of corrosion was studied. Also, times of perforation after different treatments were determined. Results indicated that oxide coatings on Mg may, for the experimental conditions surveyed, be assigned provisionally to the safe class. Results of salt-spray tests on the Mg treated by different methods are also given. 19 references. JLG (13)

Influence of Protective Layers on the Life of Metals. F. N. Speller. *Mechanical Engineering,* Vol. 57, June 1935, pages 355-360. Prevention of corrosion is attacked as an economic problem. An exhaustive review is made of metal surface reactions with the surroundings, of the means for providing protective (solid or liquid) layers, and of the tests made by various agencies to find causes of corrosion and rusting and to determine the efficiency of protective measures. Ha (13)

Precipitation Hardening and Corrosion (Aushärtung und Korrosion). E. Söhnchen. *Giesserei,* Vol. 22, June 7, 1935, pages 294-296. The relation between corrosion and precipitation hardening is investigated for hardenable Al alloys. It is stated that a considerable intercrystalline corrosion in Al-Cu alloys takes place in the range of certain temperatures. The maximum corrosion depends on the time used for tempering and is found in the range of highest precipitation hardening. The relation between ultimate strength σ_B and time after which corrosion begins can be expressed by $\log \sigma_B = k \times z + b$, which formula is represented by a curve. 6 references. Ha (13)

Influence of Alloy Additions on High Chromium Steels (Influence des Eléments d'Addition sur les Propriétés des Aciers à Haute Teneur en Chrome). R. Vaillail. *Métaux et Machines (Science et Industrie),* Vol. 19, Apr. 1935, pages 120-128. (a) Effect of Ni on 12-14% Cr steel: Ni increases ability of steel to harden by quenching. Ni has a valuable effect in low C steels in which it increases hardness after quenching. (b) Effect of Ni on 17-20% Cr steel: Without Ni this steel does not respond to quench and has poor properties. 2-3% Ni improves considerably quenching ability and toughness and does not decrease corrosion resistance as would an increase of C up to 0.6%. (c) Properties of austenitic Ni-Cr steels: Properties are described at length. (d) Effect of heating in the range 500°-900° C. on a softened austenitic Ni-Cr steel: Carbide precipitation is discussed. (e) Work-hardening of austenitic Ni-Cr steels: These steels have a marked tendency to work-harden and their hardening chart shows some similarity to that of Mn steel. It is pointed out that breaking load is much affected by speed of stressing during the test. Work-hardening can be easily suppressed by suitable softening heat treatment. (f) Effects of various alloy additions in austenitic Ni-Cr steels: 2-4% Mo increase corrosion resistance. Cu, W, Si, additions have a similar effect. (g) Very high Ni-Cr steels: These steels are particularly interesting when good mechanical strength is needed at high temperatures. Last section deals briefly with Cr-Si and Cr-Mn steels. FR (13)

Lessons from Failures Aid Steel Makers in Combatting Corrosion. Ernest E. Thum. *Oil & Gas Journal,* Vol. 33, Apr. 11, 1935, pages 50, 55. The Bureau of Construction and Repair, U. S. Navy, has been using 18-8 Cr-Ni alloy in warships for deck houses, floors, hatch covers and a variety of other structures exposed to atmospheric corrosion in port and to dashing spray or water in a seaway. These uses have been successful. However, 18-8 did not stand up for gasoline storage tanks and fire lines where exposed to stagnant sea water. Tests for such service are projected for the following materials: 18-8 with 3% Mo; 18-8 with 5% Mn and 1% Cu; Monel Metal; 70-30 Cu-Ni and rubber-lined steel. VVK (13)

Study on the Passivity of Iron and Steel in Nitric Acid Solution V. Yôichi Yamamoto. *Bulletin Institute of Chemical & Physical Research, Tokyo,* Vol. 14, May 1935, pages 374-382. In Japanese. *Scientific Papers & Abstracts Bulletin Institute of Chemical & Physical Research,* Tokyo, Vol. 27, May 1935, pages 27-28. In English. Pursuing previous research (See *Metals & Alloys,* Vol. 4, Sept. 1933, page MA 281 L-10; Vol. 6, Feb. 1935, page MA 75 L-7; Mar. 1935, page MA 123 R-4; Apr. 1935, page 167 L-9) a study of the effect of volume of the solution, in which the test piece is immersed, on the appearance of the passivity of soft steel and cast Fe in conc. HNO_3 was made. The critical concentration at which Fe and steel becomes passive was lowered according to the increase of volume of solution. For example, with 1200 cc. HNO_3 the soft steel sample became passive in 48% HNO_3 solution while with 200 cc. solution, passivity began to appear above 52% HNO_3 WH (13)

Study on the Passivity of Iron and Steel in Nitric Acid Solution VI. Yôichi Yamamoto. *Bulletin Institute of Chemical & Physical Research, Tokyo,* Vol. 14, May 1935, pages 383-395. In Japanese. *Scientific Papers & Abstracts Bulletin Institute of Chemical & Physical Research, Tokyo,* Vol. 27, May 1935, page 28. In English. The effect of the thickness of the test piece on the appearance of passivity of soft steel was investigated and found to become difficult with decreasing thicknesses of samples of the same diameter. For instance, a steel sample of 2 mm. thickness became passive in HNO_3 solution above 50.5%, while a 10 mm. specimen easily became passive at a concentration of 48% HNO_3. It is concluded that the temperature rise of heavier test pieces of the same diameter is prevented by its heat capacity and the piece becomes easily passive because of this prevention of the temperature rise of the whole test piece. (See also abstract above.) WH (13)

Anhydrous Ammonia Used in Refining as Refrigerant Neutralizer and for the Retarding of Corrosion. E. R. Woodward. *Oil & Gas Journal,* Vol. 32, Sept. 13, 1934, pages 33, 36, 39. A considerable section of this article reviews the use of ammonia for the prevention of corrosion in oil refining. VVK (13)

Diseases of Steels and Other Metals and Their Prevention. Robert S. Williams. *American Dyestuff Reporter,* Vol. 24, July 1, 1935, pages 235-239. Corrosion as encountered in the textile industry may be classed as: (1) general, inferring the general thinning of the wall of the corroded material, (2) local or pitting, and (3) embrittlement, involving a combination of stress and corrosion. The main factors involved in causing corrosion are: acids, salts, electrolysis, and oxygen. Ferrous and non-ferrous metals offer resistance to corrosion. A Cu-Be alloy containing 3% Be is very resistant to corrosion. A discussion is included. WHB (13)

The Action of Nitrocellulose Solutions upon Various Constructional Materials. S. Skljarenko, A. Pakschwer & O. Gelikonowa. *Synthetic & Applied Finishes,* Vol. 5, Feb. 1935, pages 264-270. See *Metals & Alloys,* Vol. 6, Feb. 1935, page MA 77R/1. EF (13)

Pipe Corrosion Experiments, Catskill Supply, New York City. Frank E. Hale. *Journal American Water Works Association,* Vol. 26, Oct. 1934, pages 1315-1347. A large scale corrosion experiment using 3 makes of wrought Fe, steel, brass, Cu, Pb, cement-lined steel, galvanized wrought Fe and galvanized steel pipe (¾") were carried out in raw water, and water containing 5 and 10 p.p.m. silica, 5 and 10 p.p.m. soda ash, 4.5 p.p.m. lime hydrate, and 4 p.p.m. sodium hydrate. Both hot and cold water were used and 2 series were run each of 2 years duration. Loss of weight, O_2 consumed and reduction of flow were measured. Data are presented in tables and charts with general discussion. The experiment is to be continued. VVK (13)

Corrosion Experiments on Chromium Deposits in Salt Spray and Mechanical Testing (Korrosionsversuche an galvanischen Chromniederschlägen in Salzprühnebeln und mechanische Prüfung). Hütter. *Werkstoffe und Korrosion,* Vol. 10, May 25, 1935, pages 25-26. The various forms which have been developed for testing electrolytic deposits for corrosion in salt sprays are reviewed; to shorten the time of test some methods also used electric current and boiling tests. Mechanical tests for the behavior of Cr deposits have not found wide application; bending and hardness tests are applied, but the Brinell test cannot be employed. Deposits on a very hard base (e.g. glass hard steel) may be tested with the diamond cone by Ludwik. 5 references. Ha (13)

Corrosion of Metals and Alloys at Elevated Temperatures (Corrosion des métaux et alliages aux temperatures élevées). H. Jolivet. *Aciers Speciaux, métaux et alliages,* Vol. 9, Oct. 1934, pages 349-353. Electrolytic Fe heated in oxygen at 1000° C. shows several layers of oxide as follows: next to metal there is an adherent film, then a thin space between the film and the FeO phase. The FeO consists of about 30% of the entire thickness of the scale. Between FeO and FeO (partly decomposed as Fe_3O_4) there is another small gap. This second phase FeO (partly decomposed) is followed by Fe_3O_4 phase, which in turn is followed by Fe_2O_3 phase. The third space in scale is at about the middle of Fe_2O_3 phase. The effect of gases on corrosion of metals at high temperatures is very complex. The most corrosive gases are O and S or their derivatives. GTM (13)

Clad Metals, Roller Clutch Used in Bottler. A. J. Lippold. *Machine Design,* Vol. 7, May 1935, pages 17-20. Cd plating is widely used in bottle filling machine as well as tinned or galvanized cast Fe to resist corrosion. WH (13)

Causes of Crack Failures in Riveted Boilers (Ursache von Rissschäden an genieteten Kesseltrommeln). R. Rist. *Zeitschrift Verein deutscher Ingenieure,* Vol. 79, June 29, 1935, pages 812-813. Doctor's thesis. Alternating stresses as they occur in boiler operation can lead to fatigue failure of the material. Two kinds of fractures could be distinguished: fractures with granular structure in cracks at rivet seams and in shell plates, and fractures showing the smooth, grainless structure of a fatigue fracture in the flanged bottom plates. In the former, the influence of intercrystalline corrosion can be prevented by correction selection of material and manufacturing processes and proper feed water treatment. Actual fatigue failures were much less frequently observed. Ha (13)

The Anodic Passivation of Gold. William James Shutt & Arthur Walton. *Transactions Faraday Society,* Vol. 30, Oct. 1934, pages 914-926. Contains bibliography. By the use of a valve operated oscillograph, records of the potential variations at the anodically polarized gold electrode were obtained. The maximum limiting current densities for anodic solution of gold, and the times required for passivation were measured in *N* HCl, KCl, KBr and SO_4- - solutions at 25° and in *N* HCl, over a range of temperature from 15 to 65° C. The product obtained by multiplying the current in excess of the limiting current, by the time of passivation was shown to be a constant for a given electrolyte. Both the limiting current density and the coulombs required for passivation are approximately proportional to the halogen ion concentration. Agitation of the electrolyte had little effect on the relations found to hold so long as the stirring is sufficiently vigorous to obtain a uniform concentration of electrolyte up to the electrode surface. It appears that the anion must be absorbed upon the electrode surface before anodic action can take place. The final maximum of anodic passivation is a direct discharge of hydroxyl ions with the formation of a surface layer of gold peroxide which is continuous with the crystal lattice of the metal. PRK (13)

Fight Corrosion. Phillip H. Smith. *Scientific American,* Vol. 153, July 1935, pages 20-23. Use of metals discussed for various purposes to resist corrosion. Use of Cu stools instead of cast Fe in pouring into Fe ingot molds; casting of Fe in Cu molds and Be-Cu alloys are discussed. An etched design in Cu is said to be obtained by using a latex impregnated lace-pattern textile over the Cu and sand blasting. The sand rebounds from the textile but etches the Cu not covered by the pattern. WB (13)

Our Personal Experience in the Chemical Industry. A. Schroeder. *Metallizer,* Vol. 3, June 10, 1935, pages 4-5. Applications and mechanical difficulties in metal spraying coatings for prevention of corrosion or product contamination are recounted. Spraying 0.005″ of tin over 0.003″ of zinc on steel tanks was found to be very effective. BWG (13)

Electrolytic Treatment of Zinc. Joseph Schulein. *Transactions Electrochemical Society,* Vol. 66, 1934, pages 223-228. When Zn or Zn-coated articles are treated as alternating current electrodes in a chromic acid bath, the Zn surface is chemically changed and the corrosion resistance is greatly increased. The Zn compound formed on the surface is not definitely known, nor is the theory of the reaction satisfactorily formulated as yet. Preliminary results on the corrosion resistance of electro-galvanized steel treated by this chromic acid process are recorded. (13)

Ferrous and Non-Ferrous Alloys. Max A. Shaffer. *Chemical & Metallurgical Engineering,* Vol. 42, July 1935, pages 383-386. This is a supplement to Chemical & Metallurgical Engineering Directory of Corrosion-Resistant Materials for 1934-1935. Ferrous and non-ferrous alloys are arranged by their composition, trade names being used. PRK (13)

Corrosion. T. M. Service. *Journal West of Scotland Iron & Steel Institute,* Vol. 42, Jan. 1935, pages 53-60. The electrochemical theory of corrosion appears better able to account for the phenomena observed than the colloidal theory. It is considered that differential aeration, leading to differences in O concentration, is largely responsible for corrosion. This is borne out by experiments and by the behavior of condenser tubes, ships' plates, etc., in which areas not readily accessible to oxygen are found to act as centres of corrosion. Pitting and localized corrosion may be explained on this basis. If the corrosion product is insoluble, attack will diminish or cease; if it is soluble, corrosion will proceed. GTM (13)

Effect of Different Concentrations of NaCl and H_2O_2 on the Result of Accelerated Corrosion Tests (Ueber den Einfluss verschiedener Konzentrationen von NaCl and H_2O_2 auf das Ergebnis von Schnell-Korrosionsversuchen). H. Röhrig & K. Schönherr. *Korrosion & Metallschutz,* Vol. 1, June 1935, pages 136-137. While the Na concentration had little influence in accelerated test (as determined by tensile and elongation tests of a wire) increasing concentration of H_2O_2 reduced elongation quite considerably. The reason is evidently the increased O content of the solution but not the increase in NaCl concentration. Ha (13)

Corrosion of Metals by Phosphoric Acid. F. A. Rohrman. *Chemical & Metallurgical Engineering,* Vol. 22, July 1935, pages 368-369. Crude phosphoric acid ranges from 40-58% P_2O_5, 0.2-4.% SO_3, .3-2.% F_2, .1-1.75% As. As reduces the corrosive action on Fe to a marked degree. H_2SO_4 aids in protecting Pb. Recent tests showed that the following alloys lost less than .5 g./dm.^{2}/500 hrs. at 95° C: Ni-Cr-Mo (8-12, 18-30, 3-4) steels. Chrome irons (Cr 30) and Hastalloy D. Corrosion losses under other conditions of time and temperature are also given. PRK (13)

The Effect of Heat Treatment on the Corrosion of High Purity Aluminum. F. A. Rohrman. *Transactions Electrochemical Society,* Vol. 66, 1934, pages 229-237. A study is made of the corrosion of carefully annealed, high-purity, partly cold-worked Al which had been subjected to different quenching temperatures. When nearly identical samples of this metal were given the same annealing treatment, yet subjected to different quenching temperatures, a very great difference was noted in their behavior in HCl solutions. Furnace-cooled samples and those quenched from a few degrees above room temperature show a slightly greater initial rate of attack, while those quenched from the higher temperatures show a decided intergranular attack which finally results in their complete disintegration. No definite reasons are presented for the anomalous behavior, although several possible explanations are discussed. (13)

Chemical Corrosion Phenomena and Wear in the Interior of Cylinders of Internal Combustion Motors (I Fenomeni di Corrosione chimica e l'Usura nell' Interno delle Canne dei Cilindri di Motori a Combustione interna). V. S. Prever. *Industria Meccanica,* Vol. 17, June 1935, pages 489-492. Experiments into the causes of internal corrosion of cylinders are reviewed. Chemical and mechanical causes act simultaneously with the former more predominant. Materials should be selected which are as little as possible liable to attack by the combustion gases, in particular to CO_2. Using H as fuel reduced wear considerably. The results of corrosion and wear tests with various compositions of cast iron are described in detail. Ha (13)

Deterioration of Structures in Sea-Water. *Commonwealth Engineer,* Vol. 21, June 1, 1934, page 365. See *Metals & Alloys,* Vol. 6, June 1935, page MA 251L/2. WH (13)

Materials of Construction for Process Industries from the Viewpoint of the User. *Chemical & Metallurgical Engineering,* Vol. 41, Oct. 1934, pages 513-534. 55 short articles by production engineers tell of the present practices in the use of metals and other materials in the chemical industry. The processes covered are: Acetic Acid, Acetic Anhydride, Acetone, Aluminum Chloride, Aluminum Sulphate, Ammonia-Soda Alkalis, Ammonia, Ammonium Nitrate, Ammonium Phosphate, Beet Sugar, Bromine, Byproduct Coke, Calcium Chloride, Cane Sugar Refining, Carbon Tetrachloride, Cellulose Acetate, Copper Sulphate, Chromates and Bichromates, Coal Tar Refining, Dry Batteries, Dyes, Dynamite, Electrical Manufacturing, Ethyl Alcohol, Electrolytic Caustic, Glass, Glycerine, Hydrochloric Acid, Iodine, Linseed Oil, Lithopone, Methanol, Nitrate of Soda, Nitric Acid, Petroleum Refining, Portland Cement, Potash, Printing Ink, Rubber, Salt, Sodium Hypochlorite, Soda Pulp, Soap, Sodium Sulphide, Stearic Acid and Red Oil, Sulphite Pulp, Sulphuric Acid, Tannic Acid, Tartaric Acid, Viscose Rayon, White Lead, Wood Rosin and Turpentine. PRK (13)

Allotropy and Corrosion (Allotropie en Corrsie). E. Cohen. *De Ingenieur,* Vol. 50, June 21, 1935, pages Mk13-Mk22. Recent investigations on the influence of mechanical deformations of metals on the transformation velocity in allotrope modifications, and the importance of this influence for the study of corrosion phenomena are discussed. Experiments were made to show the influences of deformation by rolling, tension and compression on tin. All 3 kinds increased the transformation velocity of white tin into gray tin very considerably, while annealing after deforming reduced the velocity very greatly. The velocity increases with higher deformation. The conception of corrosion as being the "destruction of a solid substance which starts at the surface by unintentional chemical or electrochemical attacks" would exclude corrosion by mechanical forces, yet there exists a quite definite connection as the mechanical treatment of a metal may accelerate or prevent corrosion. Ha (13)

Rustproofing Process. *Heat Treating & Forging,* Vol. 21, June 1935, page 288. **Rustproofs Lamps with New Process.** *Steel,* Vol. 97, July 29, 1935, page 34. Ford Motor Company rustproofs lamp-shells by wiping surface to be coated with gasoline and putting shell in automatic machine containing bath of $Zn_3(PO_4)_2$ where it remains 4½ min. Bath is kept at 155° F. and an a.c. of 20 volts and 35-50 amps. at 60 cycles is passed through it. Zn content of bath can vary from 0.9-0.2%. Articles are then spray and dip rinsed with hot H_2O, wiped with a clean cloth and dip painted. Gasoline prevents attack on steel before deposition begins. A.c. prevents H_2 formation on shell and eliminates polarization. Complete resistance to rust after 1000 hrs. of salt spray is being obtained. MS (13)

Ford Granodizes Lamp Shells as Protection Against Rust. Burnham Finney. *Iron Age,* Vol. 136, July 11, 1935, pages 33-34. Describes a method of electro-granodizing automobile lamps by the Ford Motor Co. prior to enameling. The process results in a crystalline deposit of $Zn_3(PO_4)$. $4H_2O$ being on the surface of metal thus providing better adhesion of enamel to the steel. In case enamel coating is broken it prevents corrosion at the break and also in the area surrounding exposed portion. Equipment used is similar to that used for Cd or Ni plating. The process may be used as protective coating where enamel, lacquer or synthetic materials are used as a finish. VSP (13)

The Anodic Passivation of Gold in Chloride Solutions. G. Armstrong & J. A. B. Butler. *Transactions Faraday Society,* Vol. 30, Dec. 1934, pages 1173-1177. Measurements have been made of the times of passivation of gold electrodes in unstirred chloride solutions. The times are approximately proportional to the chloride ion concentration and are not appreciably affected by replacing HCl by KCl. If it is over 10 seconds the relation $i\ t = i_o t + a$ holds, where "i" = current, "t" = Time, "i_o" and "a" are constants. "a" is regarded as the amount of electrolysis required to produce a diffusion layer through which the diffusion of Cl^- to the electrode takes place at the constant rate of i_o. A similar interpretation is given of Shutt and Walton's observations of a relation of the same kind under conditions of violent stirring. The thickness of the diffusion layer is correlated in the 2 cases and found to be 2×10^{-3} cm., and 4×10^{-4} cm. Contains bibliography. PRK (13)

Investigation of the Structure Corrosion of Aluminum Alloys (Untersuchung der Gefügekorrosion der Aluminiumlegierungen). G. W. Akimow & A. S. Oleschko. *Korrosion & Metallschutz,* Vol. 11, June 1935, pages 125-132. Binary Al alloys were investigated as to the corrosion process of the structural constituents in 3% NaCl solution. In spite of the presence of an oxide film the structural constituents become anodic and cathodic so that electrode potentials form which finally lead to corrosion. The magnitude of the potentials and the particular constituents which play a part in the corrosion were determined for the systems Al-Zn, Al-Cu, Al-Fe, Al-Mn, Al-Ni and Al-Mg-Si. Ha (13)

Standardization of Corrosion Tests for Tubes (Einheitliche Korrosionsprüfungen für Rohre). K. Adloff. *Die Wärme,* Vol. 58, May 4, 1935, pages 286-289. Discusses the following points: galvanic currents and tube corrosion, critical survey of present corrosion methods for tubes, critical comparison between short-time tests and accelerated long-time corrosion tests, scheme for ideal corrosion conditions, examples and conclusions. EF (13)

The Effect of Ferrous Iron in Solutions of Citric Acid of Different Hydrogen Ion Concentrations on the Corrosion of Iron in the Presence of a Limited Supply of Air. J. N. Bryan. *Transactions Faraday Society,* Vol. 30, Nov. 1934, pages 1059-1062. Contains bibliography. Studies of the volume of hydrogen that was depolarized during corrosion of iron showed that more was depolarized in the presence of ferrous iron than in its absence over the entire pH range 2.4 to 5.5. PRK (13)

Greasing of Transmission Cables (Das Fetten der Freileitungsseile). Paul Behrens. *Aluminium,* Vol. 17, June 1935, pages 305-306. Greasing of Al cables with green vaseline proved to be conducive to longer life inasmuch as waste gases of Al plants did not attack the cables so treated. Rain washes the vaseline off very slowly. Connectors, clamps and fittings, should be coated with vaseline. Ha (13)

Potentiometric Studies of Passivity. JOHN STEINER & LOUIS KAHLENBERG. *Transactions Electrochemical Society,* Vol. 66, 1934, pages 205-212. The electrode potentials of various samples of Fe, of certain ferrous alloys of Al, W, Cr and Pt and 2 varieties of C were measured in nitric acid of varying concentrations from dilute to fuming. By means of the potentiometer the passive state was readily distinguished from the active and the minimum concentration of acid that will cause passivity accurately determined. The results are given in the form of curves. Direct evidence for the support of the oxide theory of passivity was found only in the case of W. Alternating activity and passivity is observed only when part of the electrode is immersed in the nitric acid; it does not occur when the metal is completely immersed. The addition of easily passivated metals such as Cr and Ni, to Fe yields alloys which are more readily passivated than Fe itself; while the addition of a less easily passivated metal, like Cu causes the alloy to be less readily passivated than Fe. (13)

Some Optical Observations on the Effect of Ozone and Air on Metals. L. TRONSTAD & T. HÖVERSTAD. *Transactions Faraday Society,* Vol. 30, Dec. 1934, pages 1114-1127. Contains bibliography. Quantitative information about films formed on Ag, Cu, Zn, Fe, eutectoid Fe and austenitic stainless steel, in moist and dry ozone was obtained by means of the optical method of Drude. In moist ozone, no highly protective film was formed. An attack was attributable to atmospheric corrosion. Water vapor may be absorbed by the corrosion products. Due to corrosion, the films broke down at weak points and hydrated corrosion products formed which generally offered very little resistance to oxygen diffusion compared with the more compact anhydrous oxide film. On austenitic stainless steel very little attack occurred. Eutectoid steel, with a larger number of weak points, was more heavily attacked than iron with a smaller number. The water functioned as an opening agent rather than as a catalyst of the decomposition of ozone. In dry ozone, highly protective films were obtained with Ag, Fe, steel and stainless steel, but on Cu and Zn the films were less protective. On Zn, the growth of the films revealed a linear disposition, agreeing with the facts of ordinary atmospheric corrosion. This affords evidence of the reliability of the optical method. PRK (13)

Alloys that Resist Severe Corrosive Conditions. H. L. R. WHITNEY. *Chemical & Metallurgical Engineering,* Vol. 42, July 1935, pages 370-371. Based on paper presented before New York section of American Welding Society, May 15, 1935. A discussion of the methods of testing corrosion-resisting material as influenced by fabrication is given. PRK (13)

Alloyed Sucker Rods Show Well. B. B. WESTCOTT & L. W. VOLLMER. *Steel,* Vol. 96, Feb. 18, 1935, page 50. Abstract of paper read before the American Institute of Mining & Metallurgical Engineers. See "Recent Developments in the Manufacture of Sucker Rods," *Metals & Alloys,* Vol. 6, June 1935, page MA 256L/8. MS (13)

Pitting Due to Rolling Contact. S. WAY. *Journal of Applied Mechanics, A.S.M.E.,* Vol. 2, June 1935, pages A49-A58. Pitting as the term is used here is a form of failure occurring in gears, bearings, and other parts under heavy loads. Experiments seem to prove that oil must be present for pitting to take place, that the oil must be of a viscosity low enough to penetrate fine cracks if the cracks are to grow, and that the cracks will grow only if they have a certain initial direction. The critical viscosity of a lubricant does not increase appreciably at high load. The rougher the surface finish the greater the likelihood of pitting. Possible methods of preventing pitting are seen in using no oil (which is practically impossible), using highly polished surface, increasing the viscosity of oil, and using a very hard surface and tough interior as obtained by nitriding. The third and fourth ways offer practical means for prevention. A theory of pitting under contact is developed. Ha (13)

Corrosion of Steel in Shipbuilding. W. E. J. LEWIS. *Journal West of Scotland Iron & Steel Institute,* Vol. 42, Jan. 1935, pages 61-66. Corrosion is becoming more serious every year. In the case of rivets, this may be due to the use of rimming steel. As far as plates are concerned, the higher temperatures used in rolling and the shorter weathering time seem to be important factors. Descaling by pickling is effective, but expensive. Internal corrosion may be brought about by the presence of electrolytes in a liquid cargo (such as petroleum); attack is most severe at the bottom of the tanks. The bottom of the tank may be cemented, but the remedy is costly. GTM (13)

A New (Vacuum) Tube Voltmeter (Ein neues Röhrenvoltmeter). H. POLLATSCHEK. *Zeitschrift für Elektrochemie,* Vol. 41, June 1935, pages 340-344. A vacuum tube voltmeter is described which has an accuracy of ± 1 mv. and a grid current of less than 10^{-11} amp. and can operate as long as desired without change in the zero point. It is considered particularly valuable in the measurement of e.m.f.'s of elementary cells such as are encountered in corrosion phenomena. The hook-up is shown in diagrams. WB (13)

Anomalies Observed in the Rate of Corrosion of Zinc. J. E. MACONACHIE. *Transactions Electrochemical Society,* Vol. 66, 1934, pages 213-221. The initial corrosion rate of Zn in distilled H_2O is greatly increased by increasing temperature up to about 60° C., above which the rate decreases. The corrosion rate at 60° C., appears subject to an anomalous fluctuation which can only be explained on the basis of a reversal of the corrosion reaction. There appears to be a surface condition, not affected by pickling for half a minute in normal HCl, which causes Zn to be extraordinarily resistant to attack by distilled H_2O. The occurrence of this condition is infrequent in fresh galvanized Fe sheet, but it appears to a considerable extent after aging. Individual specimens cut from one sheet show differences in their susceptibility to corrosion which appear to be independent of the method of measurement. (13)

Corrosion Research and Ten Years Government Committee for Metal Protection (Korrosionsforschung und 10 Jahre Reichsausschuss für Metallschutz). E. MAASS. *Korrosion & Metallschutz,* Vol. 11, May 1935, pages 97-100. Purpose, organization and work done and in hand are outlined. Ha (13)

Effect of Atmospheric Exposure on Nonferrous Wires. J. C. HUDSON. *Engineering,* Vol. 139, Mar. 15, 1935, pages 290-291. Abstract of paper "The Effect of Five Years' Atmospheric Exposure on the Breaking Load and Electrical Resistance of Nonferrous Wires." See *Metals & Alloys,* Vol. 6, June 1935, page MA 252L/9. VSP (13)

Copper Steels (Les aciers au cuivre). E. HERZOG. *Aciers Spéciaux, Métaux et Alliages,* Vol. 9, Oct. 1934, pages 364-377. 29 references. Copper steels are divided into 3 classes—(a) low C steels containing 0.3-0.5% Cu, which are resistant to acid and atmospheric corrosion, (b) medium C steels or Cr-Cu construction alloy steels with 0.5% Cu and 0.5% Cr used for elevated temperatures, (c) low carbon steels containing 0.8 to 1.2% Cu used for elevated temperatures. The speed of solution of the low C steels in HCl and H_2SO_4 is sensibly diminished by the addition of 0.3 to 0.5 Cu to the steels. The protective effect in H_2SO_4 varies from 40% in a solution of 0.08 g./liter to 90% in a 7.00 g./liter H_2SO_4 solution. In HCl the decrease in corrosion due to Cu varies from 30% at 1% to 65% in 20% HCl solutions. Temperature accelerates the corrosion, the coefficient of temperature is 2-3 at 20° to 60° C., but the speed of corrosion is much lower at 50-60° C. in Cu steels than in steels without Cu. Addition of Cu reduces the tendency of low and medium C steels to corrode in atmospheres rich in sulphurous gases such as exist in the industrial centres. In short time tests Cu lowers the corrosion attack by 25% while in long run tests about 50%. All other factors being the same, 0.8 to 1.2% Cu in steel improves the physical properties particularly after heat treatment at 500° C. In conclusion an addition of 0.3 to 0.5% Cu improves considerably the resistance to chemical attack, acid atmospheres and to HCl, H_2SO_4. GTM (13)

Measurements Show Wear Uniformly Distributed Around Cylinder Bore. P. M. HELDT. *Automotive Industries,* Vol. 73, July 20, 1935, pages 86-87. Numerous measurements made on worn cylinders show that there may be some wear due to abrasion under conditions of poor lubrication, but other factors are more important, since wear is greatest at the belt covered by the top piston ring when it is at its highest position. Corrosion due to acid products of combustion and distortion of the cylinder wall due to non-uniformity of wall thicknesses or unequal pull of cylinder head studs are the heaviest wear agents. As a rule, cylinder wear is substantially equal across the block and lengthwise of the block, over the entire length of the bore. BWG (13)

Corrosion at Contact with Glass. R. B. MEARS & U. R. EVANS. *Transactions Faraday Society,* Vol. 30, May 1934, pages 417-423. Contains bibliography. The frequency of attack was measured at contacts between cylindrical rods of glass and of steel to determine which explanation was most plausible—the "differential aeration" or "rival interface." The results, given in tables, are summarized as follows: The frequency of corrosion of steel rods in 0.5N Na_2CO_3 solution at points where second rods rest on them, increases with the diameter of the second rod, is greater for steel—steel contacts than steel—glass contacts, is smaller under conditions of agitation than of stagnancy, is reduced by cuts in the metal near the contact, is the same after 10 minutes as after 2 days, is same in old and fresh solutions. The results indicate that differential aeration rather than "rival interface effect" is main agency at work. PRK (13)

Beyond Today's Materials of Chemical Engineering. HAROLD L. MAXWELL. *Chemical & Metallurgical Engineering,* Vol. 41, Oct. 1934, pages 510-512. The progress that is being made in the development of new materials is discussed. Present trend appears to be away from excessively large installations of low cost materials and toward smaller sized units operating under more severe conditions of temperature, pressure and corrosion. PRK (13)

Cements for Corrosion, Heat and Solvent Resistance. THEODORE R. OLIVE. *Chemical & Metallurgical Engineering,* Vol. 41, Oct. 1934, pages 537-540. Formulas are given for cements for various purposes. PRK (13)

The Deterioration of Colliery Haulage Ropes in Service. S. M. DIXON & M. A. HOGAN. *Safety in Mines Research Board (Great Britain) Paper* No. 92, 1935, 32 pages. Results of examination of causes of failure of 23 haulage ropes are presented. The deterioration is due to wear, corrosion and fatigue. Haulage ropes are particularly susceptible to external wear. If the roadway is wet, corrosion of the worn surfaces will accelerate the deterioration on account of the abrasive action of the corrosion products on the various surfaces which rub together as the rope is bent over drum and pulleys. If a rope is undergoing internal corrosion, this will be accelerated by wear between the wires as the rope is bent. Wear and corrosion together tend to produce rapid deterioration resulting in serious reduction in the cross-sectional area of the wires. When the section of the wires is reduced sufficiently to cause the stress on them to exceed the fatigue limit, deterioration by fatigue will begin. The precautions required for the safety of haulage ropes are discussed, including the strength of the rope, the type of rope, its construction, the material in the wire, the size of the wire, flattened strands, lubrication in manufacture, maintenance, lubrication in service, examination, recapping, capels for haulage ropes, etc. JCC + AHE (13)

The Mechanism of Metallic Corrosion. A View Suggested by Whitby's Recent Papers. U. R. EVANS & T. P. HOAR. *Transactions Faraday Society,* Vol. 30, May 1934, pages 424-432. Contains bibliography. Since free cations exist in the lattice of any ordinary metal when corroded, the cation merely becomes hydrated and spatially separated from attendant conductivity electrons. Anions, often as not, continue to carry their charge after corrosion. Thus Cl^- will deposit on Ag plate made up of a lattice of Ag-ions,—i.e. deposition of ions occurs, and corrosion stops due to insolubility of corrosion product. But Zn-ions will continue to leave Zn plate and go into a solution of Cl^-, since the salt is soluble. The anodic corrosion can take place, if reference plane be taken as the uncorroded part of metal, by the motion both of cations and anions across the metal-liquid interface. PRK (13)

A Reflection Meter and Its Application. W. P. DIGBY. *Engineer,* Vol. 159, Mar. 1, 1935, pages 219-221; Mar 8, pages 254-255. By the use of photometric records of the loss of reflecting power of polished metals or change in surface of paints the author compared: (1) Behavior of group of metals exposed to some corrosive medium, whether gaseous or liquid; (2) Relative intensity of action upon same metal of corrosive media of varying composition; and (3) Color permanence of paints used in material protection. Metals used in tests were Au 9.5% and Cu 7.5%, Au-Cu eutectic (72% Au and 28% Cu) and several grades of steel including stainless steel. Measurements were made on rate of fading of paints under different conditions of exposure. Metals were in different positions and in different localities. Results of tests are given in detail. VSP (13)

14. APPLICATION OF METALS AND ALLOYS

All-Metal Staterooms Thrust at Fire Hazard at Sea. *Steel*, Vol. 97, July 15, 1935, pages 19-20, 91. Bethlehem Shipbuilding Corp., Quincy, Mass. has developed an all-metal state-room for ships which can be built within the weight allowance permitted in modern ship design for a reasonable cost and with pleasing appearance. Bulkheads, ceilings, decks, structural details, and furring are of steel. Trim is Al. Chairs of Al, other furniture being of steel. MS (14)

The Use of Metals in Automotive Transportation. J. M. Watson. *Iron Age*, Vol. 135, June 13, 1935, pages 31-34, 37. From a paper read before the American Society for Metals, at New York, May 24, 1935. Gives an analysis of the use of various metals and alloys in automotive construction. States that it has been the mutual coöperation of engineer, metallurgist and steel maker that has made these remarkable developments possible. VSP (14)

Modern Metals in Modern Designing. Raymond Loewy. *Iron Age*, Vol. 135, June 13, 1935, pages 28-30. Instead of having to adapt his ideas to a limited selection, the designer has available a diversity of metals. The stainless alloys are of the greatest aid because of their strength, corrosion resistance and moderate cost. Among white metals there is a variation in color. Monel metal is silver, with an undertone of blue. Ni has a yellowish tone under its silver, while stainless steel is blue-gray. In realm of purely decorative metals the development of Pd leaf provides a material with the color and nontarnishability of Pt. VSP (14)

Rear and Under Chassis Mounted Engines Increasingly Popular in Motor Bus Field. Part III. Mack Buses. P. M. Heldt. *Automotive Industries*, Vol. 72, June 29, 1935, pages 864-866. The new Mack streamlined 30 passenger coach has the engine mounted in the rear and uses light alloys to a considerable extent in the body frame. Cu steel is used for posts and columns, Al for the roof and for floor foundations and rails. A still later model just being produced uses Al alloy for both the chassis frame and all of the body framing. BWG (14)

Aluminum Alloys and Steel Combined in Large Shovel Dipper for Coal Stripping Work. *Steel*, Vol. 97, July 15, 1935, pages 36-37. Describes dipper built by Marion Steam Shovel Co., Marion, O. Al alloy plates, angles and castings are used. Parts subject to heavy abrasion such as cutting lip, teeth, and bottom band are clad with steel. Cutting lip is a Mn steel casting. Use of Al has made it possible to increase capacity 33⅓% without adding to weight, increasing operating costs, or reducing operating speed. MS (14)

Alloy Electrodes for Luminous Discharge Tubes and Their Application (Electrodes à Alliages pour Tubes à Décharge lumineuse et leurs Applications). J. B. J. Marcel Abadie. *Revue Générale de l'Electricité*, Vol. 37, May 18, 1935, pages 627-633. Electrodes of alloys of a metal of a more or less refractory character, as Ni, Fe, Mo, W, and alkali metals or alkaline earth metals offer advantages for luminous tubes in as much as they have a good electron emission at fairly low temperatures, e.g. an alloy of Ni and Ba starts to emit at 45 volts. Properties, preparation and physical behavior of various alloys are described. Ha (14)

Progress in Metals. Albert J. Dornblatt. *Heat Treating & Forging*, Vol. 21, Feb. 1935, pages 80-82; Mar. 1935, pages 129-130. Historical outline of the application of metals in various fields with chief attention to recent developments. Tabulates applications and alloys developed to meet their special requirements. MS (14)

14a. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Silver Coatings and Their Applications for Apparatus of Chemical Factories (Ueber Silberüberzüge und ihre Anwendung für Apparate der Chemischen Fabrik). H. M. Forstner. *Oberflächentechnik*, Vol 12, Apr. 16, 1935, pages 91-94; May 7, 1935, pages 109-112; May 21, 1935, pages 119-122; June 4, 1935, pages 137-138; June 18, 1935, pages 147-150. The properties of Ag are discussed with particular respect to their usefulness in chemical industries. Apparatus of pure Ag is used in the manufacture of acetic acid, wine, fruit wines which must be very pure as the presence of traces of mineral acids, e.g. HCl in acetic acid, reduces the resistance of Ag considerably. Methods for reinforcing Ag in apparatus with other mechanically stronger materials are described, and an exhaustive review is given of the manufacture of electrolytic Ag deposits, choice of eventual intermediary layers of other metals, electrolytes, structure of the deposit, throwing power of the baths, corrosion resistance against different substances, and economical questions. For Ag plating of steel, intermediary layers of Ni and Cu are recommended; the thicknesses for a Cu deposit directly on Fe should be from KCN electrolysis, 0.01-0.03 mm.; for Ni deposits on Fe, from warm, boric acid electrolytes, 0.02-0.04 mm.; for Cu on Ni from $CuSo_4$ baths, 0.03-0.05 mm. The most satisfactory Ag deposits are obtained from potassium silver cyanide solutions although lately tests with non-poisonous electrolytes have been made successfully. The thickness of Ag deposits on chemical apparatus varies between 0.1-0.3 mm., sometimes 0.5 mm., according to the chemical effect of the material with which it comes into contact and to the manner of subsequent surface treatment. Ag plated apparatus is preferable to solid Ag apparatus. A complete list is given of the substances which attack or corrode Ag. 105 references. Ha (14a)

Light Metals and their Application in Railroad Practice (Leichtmetalle und ihre Verwendung im Eisenbahnwesen). F. Reidemeister. *Aluminium*, Vol. 17, Apr. 1935, pages 217-220. The savings made possible by replacing steel parts with light metal parts particularly in the operation of trains are illustrated by an example of a suburban train schedule of the German state railways. Ha (14a)

Heat Protection by "Metal" Wall Papers (Wärmeschutz durch Metalltapeten). A. F. Dufton. *Aluminium*, Vol. 17, Apr. 1935, pages 225-226. Tests indicate that it is possible to reduce the radiation of heat from walls and thus obtain better heating of rooms by covering the wall at the more exposed places with Al foil or Al paint. Ha (14a)

Copper in Breweries (Le Cuivre dans la Brasserie). Geo. DuBois. *Cuivre et Laiton*, Vol. 8, June 30, 1935, pages 275-282. An extensive review and discussion of use of Cu for brewing equipment. Ha (14a)

Aluminum Transmission Lines in Germany existing in December 1934 (Die Aluminum-Freileitungen in Deutschland nach dem Stand vom Dezember 1934). *Aluminium*, Vol. 17, May 1935, pages 257-258. Map and statistics according to geographical distribution and voltage; 27.9% of the total length, or 7967 km., were of Al. Ha (14a)

Aluminium Mirrors (Aluminiumspiegel). *Die Umschau in Wissenschaft & Technik*, Vol. 39, Apr. 28, 1935, page 351. Hochheim succeeded for the first time in producing mirrors by evaporating an 88/12 Al-Ag alloy which does not absorb violet and ultra-violet rays as does pure Ag. In 1931, Williams produced Cr mirrors which are immune to scratching. Cartwright & Strong prepared Ag mirrors coated with a SiO_2 layer in order to prevent gradual "blinding" of Ag due to the effect of gases. WH (14a)

An Interesting Practical Application of Cadmium-Copper (Une Application intéressante du Cuivre au Cadmium). *Cuivre et Laiton*, Vol. 8, Apr. 30, 1935, page 187. For certain reasons, underground conductors for an electric distribution system were made of Cu alloyed with Cd (percentage not given); conductivity is 50-53 as compared with 88-92% for electrolytic Cu, ultimate strength 42-45 kg./mm.^{2}, and Brinell hardness 100-115. Ha (14a)

Die Casting Applications Continue to Increase in 1935 Models. Joseph Geschelin. *Automotive Industries*, Vol. 72, Feb. 16, 1935, pages 212-214. Zn alloy die castings and their many applications in present automobile accessories are discussed. Better physical properties of the castings are being secured; also, improvements in technique in the way of intricate coring and in obtaining better electroplated finishes for corrosion and wear resistance as well as appearance. BWG (14a)

Structural Aluminum, Fabrication and Utility. R. L. Templin. *Metal Progress*, Vol. 27, May 1935, pages 34-39. Discusses the savings made possible by the use of Al in reconditioning existing bridges and similar structures to reduce the stress from dead load and thus take care of greater live load resulting from increased traffic. WLC (14a)

Making an Old Bridge Lighter. R. G. Skerrett. *Compressed Air Magazine*, Vol. 39, Apr. 1934, pages 4401-4405. Describes in detail replacement of the steel floor system of the Smithfield Street Bridge, Pittsburgh, with Al alloy members. WH (14a)

Copper in the Manufacture of Colored Papers (Le Cuivre dans la Fabrication des Papiers peints). V. Cheilly. *Cuivre et Laiton*, Vol. 8, May 15, 1935, pages 211-213. Use of Cu in paper manufacture for apparatus, printing and coloring is briefly described. Ha (14a)

Application of Light Metals in the Automobile (Application des Alliages légers dans l'Automobile). Dumas. *Usine*, Vol. 44, Apr. 25, 1935, page 29. A brief review of light metals used especially in the construction of automobiles, their composition and properties in cast and rolled state and parts for which they are preferably used. Ha (14a)

Sheet Silver for Chemical Equipment. B. A. Rogers. *Sheet Metal Industries*, Vol. 9, Feb. 1935, pages 99-100. From "Chemical and Metallurgical Engineering." Three types of linings are considered, namely: Fitted linings which are not attached to outer walls, electro-deposited linings, and duplex metal walls. AWM (14a)

Bronze Propellers For The Greatest Liner. A. Eyles. *Metal Industry*, N. Y., Vol. 32, Nov. 1934, page 385. The propellers for the new Cunarder "Queen Mary" are made of a Turbiston bronze whose composition is Cu, 55; Zn, 41; Ni, 2; Mn, 0.16; Fe, 0.84; Al, 1. The weight of each casting is 52 tons. PRK (14a)

Production and Uses of Zinc Sheet (Erzeugung und Verwendung von Zinkblech). J. Gutmann. *Zeitschrift Verein deutscher Ingenieure*, Vol. 79, May 4, 1935, pages 551-555. Review and statistical data of production in different countries, manufacturing processes, and the highly diversified uses of Zn in sheet form. Ha (14a)

Supernickel. I. T. Hook. *Welding Engineer*, Vol. 20, Apr. 1935, pages 24-26. Supernickel is a Cu-Ni alloy with 30% Ni. It is particularlly suitable for condenser tubes, in apparatus handling salt water and containers for corrosive chemicals. The annealed metal has a tensile strength of 50,000 lbs./in.^{2} with an elongation of 45% in 2 in. Cold worked, the tensile strength may be increased to 75,000 lbs./in.^{2} with 5% elongation. It retains its strength at elevated temperatures better than most Cu alloys, can be forged and cold-rolled. It is a solid solution metal in the α-phase; a small percentage of Mn acts as deoxidizer and desulphurizer. Fusion and resistance welding and soldering with Ag can be employed. High cooling strains should be avoided. Examples of application and welding procedures are described. Ha (14a)

Established Properties and Proved Applications of Beryllium Copper. R. W. Carson. *Product Engineering,* Vol. 6, May 1935, pages 175-177. The uses of Be-Cu, which is age-hardenable when quenched from 1475°-1500° F. and reheated to 500°-600° F., are reviewed. The alloy contains 2.25% Be. Hardness and strength increase rapidly during the first few minutes in the age-hardening treatment reaching a maximum within 1 to 5 hrs. A great number of examples of castings, forgings, and rolled products, used as contact points, watch springs, wrenches, etc., are described and illustrated. Ha (14a)

The Menasco C6S "Buccaneer." W. A. Hite. *Automotive Industries,* Vol. 72, Apr. 27, 1935, pages 574-575. This 6 cylinder in line air cooled airplane engine which made records in recent national air races has an inverted design in which the cylinders are mounted beneath the crank case giving many definite engineering advantages. The crankcase is cast of Al, cylinder barrels are machined from a solid forging, cylinder heads are of cast Al alloy, solid Cu gasket seals are used, pistons are Al and a large number of small parts, the crankcase cover, main bearing caps, oil pump housing, etc., are of Mg. Plain bronze backed, babbitt lined main bearings are used. BWG (14a)

Bearing Troubles. A. Hoyt Levy. *Metal Industry,* N. Y., Vol. 33, May 1935, page 159. In most bearing failures the babbitt is squeezed out of the box. This may be due to the babbitt being too soft or it may be due to the babbitt lining lifting, creating friction which generates heat causing the babbitt to soften and creep out. The lining lifts because the box is not completely tinned or it is not sufficiently anchored. A smear of oil prevents tin from binding and leaves an air space. One way to prevent a babbitt lining from lifting is to line the bearing by spraying instead of casting the babbitt. PRK (14a)

What About Wear and Fatigue in Trolley Wire. J. F. Neild. *Mass Transportation,* Vol. 31, Apr. 1935, pages 103-104. The term "crystallization" is used by the author to describe the appearance of fatigue failure in trolley wire. He favors hard drawn Cu or high conductivity Cd bronze wire for light to moderate services. For heavier service 92 or 80% conductivity Cd bronze or medium strength 65% conductivity Sn bronze wire and for hard service the high strength 40% conductivity Sn bronze wire is favored. His opinion is that impact of the trolley wheel due to imperfect joining of wire and feeders is the primary cause of "fatigue" failure. He cites the case of a trolley wire which gave exceptionally good service and which was found to have been produced from lake Cu containing a small amount of Ag. WB (14a)

Aluminum Trusses and Floor for Brooklyn Bridge. *Engineering News-Record,* Vol. 114, Apr. 18, 1935, pages 547-550. Proposed plan for reconstruction of the famous suspension bridge contemplates a new suspended structure providing 12 lanes of vehicular traffic on 2 decks without increasing the present dead loads. Existing towers, cables and anchorages are to be retained. CBJ (14a)

The Ignition of Firedamp by Broken Electric Lamp Bulbs. The Appearance of the Filaments. G. Allsop & R. V. Wheeler. *Safety in Mines Research Board (Great Britain),* Paper No. 89, 1935, 15 pages. W filaments of 2-volt vacuum and 4-volt gas-filled bulbs which had been broken (1) by a blow when cold, (2) by normal decay, and (3) by decay hastened by over-running could be distinguished by their bright appearance and steel-gray color from filaments burnt out in air or in a mixture of firedamp and air, in which case a yellow or greenish-yellow deposit of W oxide forms on the supports. AHE (14a)

Steel Progress in Steam Engineering. L. Sanderson. *Steam Engineer,* Vol. 4, Mar. 1935, pages 231-232. A review and discussion of steels suitable for various uses around a steam plant. AHE (14a)

Copper in the Construction of Roads and Fish Ponds (LeCuivre dans la Construction des Routes et dans la Construction des Piscines). M. Gossieaux. *Cuivre et Laiton,* Vol. 8, May 30, 1935, pages 227-229. Describes modern constructions using Cu in joints to counteract temperature changes. Ha (14a)

Whirling Disk Utilizes Aluminum. G. Fassin. *Machine Design,* Vol. 7, May 1935, page 33. The instrument in question is a centrifuge microscope by which specimens can be observed while being revolved at 10,000 r.p.m. The rotor is composed of 2 discs of Al with a tensile strength of 55,000 lbs./in.^{2} WH (14a)

Bi-Metal Thermometer (Das Torsionsstufenfeder-Thermometer). Walter Grundmann. *Zeitschrift für Instrumentenkunde,* Vol. 55, Apr. 1935, pages 173-174; A. Karsten. May 1935, pages 218-219. Discussion of an earlier paper by Karsten *(Zeitschrift für Instrumentenkunde,* Vol. 34, 1934, pages 274-277) who attempts to substitute bi-metal thermometers for liquid-thermometers. The sources of trouble due to (1) stressing of the utilized metals by welding and rolling (2) aging and other internal transformations (3) local defects and (4) fatigue are fully discussed. EF (14a)

Bearing Metals. F. K. von Göler & G. Sachs. *Metallgesellschaft,* No. 10, May 1935, pages 3-10. Mechanical properties and metallography of high Sn-containing white metals, high Pb-containing white metals, hardened Pb bearing metals, thin bearing linings, Cd-base bearing metals, Pb bronzes, and bearing metals with Zn and Al bases are discussed in general with respect to their particular fields of application. Pb as addition to bearing bronzes particularly improves the slip properties where high performances are required and where lubrication is imperfect. It is pressed out during variations of temperature and forms a lubricating film protecting the bronze and shaft from wear and erosion. Heavy duty bronzes contain up to 20% Sn and up to 25% Pb. Bearing metals on a Zn or Al basis have not yet met with success. Ha (14a)

Sparkless-Working Tools (Funkenlos arbeitende Werkzeuge). W. Hessenbruch. *Zeitschrift Verein deutscher Ingenieure,* Vol. 55, May 1935, page 586. The sparks produced when working with steel tools, especially C steels, often constitute a danger in certain industries. This can be obviated by replacing these tools with those made of Be alloys. Be-Cu, Be-Ni and Be-Cr-Ni alloys are used for hammers, chisels, spades, screw-drivers, trowels, etc. A table of physical properties of the 3 alloys is given. Hardness can be developed up to 460 Brinnell; they are rust-proof and resist heat up to 500° C. for Be-Cu, 700° C. for Be-Ni, and 1100° C. for Be-Cr-Ni. Ha (14a)

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Gold-Chromium Resistance Alloys (Gold-Chrom Widerstandslegierungen). A. Schulze. *Zeitschrift für Instrumentenkunde,* Vol. 55, May 1935, page 233. Experiments by Thomas at the Bureau of Standards on Au-Cr alloys containing 1.6-2.5% Cr are summarized. An alloy with 2.1% Cr is considered to be superior to the widely used manganin (86 Cu, 12 Mn, 2 Ni). EF (14a)

Beryllium Alloys and Their Utilization in Clock Manufacture (Die Berylliumlegierungen und ihre Anwendung in der Uhrentechnik). M. R. Straumann. *Zeitschrift für Instrumentenkunde,* Vol. 55, Feb. 1935, pages 91-92. **(Les alliages au béryllium et leurs applications en horologie) Bulletin annuel de la société suisse de chronométrie,** 1933, pages 20-22. Age-hardening treatment of Be alloys is considered. Alloys low in Be (∼ 1% Be) are utilized for pinions, bearings, anchor and non-magnetic wheels. Springs must be much harder (250-700 Brinell) and contain up to 2.5% Be. A Cu-Be spring of 540 kg./mm.^{2} is equivalent to a steel spring of 650 kg./mm.^{2} The suitability of Cu-Be springs is improved by longer service times. Berydur is the trade name of Cu-Be. Contracid looks like steel, is non-magnetic, corrosion and heat resistant up to 650° C. without loss of elastic properties. "Nivarox," an Fe-Ni-Be alloy with additions of W, Cr, or Mo is used for springs with certain thermo-elastic coefficients. It is corrosion resistant to moisture and practically non-magnetic. The patent situation is reviewed. EF (14a)

Low Cost [Dental] Alloys and their Application in Practice. R. C. Willett. *British Journal of Dental Science,* Vol. 80, May 1935, pages 100-101. Reprinted from *International Journal of Orthodontia.* A cheap alloy for inlays and one-piece castings can be made from 12 dwt. sterling Ag alloyed with 1 U. S. penny (Ag. 79.29, Cu 19.29, Zn 0.71, Sn 0.71%). A substitute for hard Au casting alloy contains Pd 5, Au 10, sterling Ag 85%. JCC (14a)

Aluminum Favored in Comet Design. *Machine Design,* Vol. 7, June 1935, page 23. Strong Al alloys make up the major structural material in the diesel-powered "Comet" train. Extruded shapes, flat and formed sheets and castings have been widely employed. Al rivets are used throughout for attaching all Al parts. Structural features may be taken from 3 illustrations. WH (14a)

Protection Against Sun-rays by Aluminum Foil (Schutz gegen Sonnenstrahlen mittels Aluminiumfolie). *Die Umschau in Wissenschaft & Technik,* Vol. 39, Feb. 24, 1935, page 173. Al foil has been successfully utilized in tropical helmets and roofing of shacks, barracks, etc. provided with corrugated Fe sheets, with the object of reducing the temperature underneath. WB (14a)

Alloy Orifices in Refractory Dies. *Glass Industry,* Vol. 16, June 1935, pages 176-177. General discussion of development of 90% Pt—10% Rh alloy orifice for high temperature and abrasion resistance. The orifice is mounted in refractory and delivers a constant stream of molten glass for electric lamp bulb bases. WB (14a)

Roofing with Lead-Coated Copper (Les Couvertures en Cuivre plombé). *Cuivre et Laiton,* Vol. 8, June 15, 1935, pages 263-264. To avoid the high price of Pb roofing where it is necessary for architectural reasons to maintain the gray color, Pb-coated Cu sheets are used. They are cheaper and give the same service. Ha (14a)

Requirements of Materials for Weaving Fourdrinier Wires. Hugh E. Brown. *Paper Trade Journal,* Vol. 100, Jan. 24, 1935, pages 35-38. Factors of importance in weaving fourdrinier wires are: (1) tensile strength of warp wires must be sufficient to stand tension caused by the load and the drive, (2) ductility of the wire to withstand the bending caused by running over the rolls at high speed without excessive stretching, (3) resistance to fatigue, (4) resistance to abrasion, and (5) resistance to corrosion. Latest annealing methods are described. CBJ (14a)

Modern Demands on Non-Ferrous Metals (Nutida krav paa nonferrometaller). H. Kristiansson. *Teknisk Tidskrift,* Vol. 65, May 11, 1935, pages 205-208. Paper read before the annual meeting of the Swedish Engineering Societies. Discusses Cu and Al, and a few of the more important alloys of these metals, the most common impurities encountered and the maximum quantities allowed for various purposes, as in wire, plate, rods, tubes, and castings. BHS (14a)

Rising Engine Speeds Lift Average Big End Bearing Loads to 1200 Lbs. per Sq. In. P. M. Heldt. *Automotive Industries,* Vol. 72, June 8, 1935, pages 774-775. In 12 engines covered by this analysis, 6 with cast iron and 6 with Al pistons, the specific load on the crankpin bearing at the beginning of the suction stroke varied from 975 to 1450 lbs./in.^{2} with average of 1200 lbs./in.^{2} Both the lowest and highest figures are from engines with Al pistons, hence material of piston construction is not a dependable criterion of the intensity of its bearing load. Cu-Pb bearings are used on the engine giving 1450 lbs./in.^{2} load. BWG (14a)

Silver Equipment in Chemical Plants. Irl C. Schoonover. *Chemical & Metallurgical Engineering,* Vol. 41, Oct. 1934, pages 545-546. Some interesting applications and possibilities for Ag in chemical equipment are given. PRK (14a)

High-Grade Heavy and Light Metal Bearings (Hochwertige Schwer- und Leichtmetall-Lagermetalle). H. Reininger. *Metallwaren-Industrie & Galvano-Technik, Section Werkstoffkunde und Verarbeitungstechnik,* Vol. 33, Mar. 1, 1935, pages 105-106. Discusses the following points: the conception "Bearing metal," physical requirements to be met by high-grade bearing metals, approved micro-structures and compositions, correct melting and casting technique. EF (14a)

Use of Nickel in 1934. Robert C. Stanley. *Heat Treating & Forging,* Vol. 21, Jan. 1935, pages 21-23, 28. From "Nickel Industry in 1934," issued by the International Nickel Company. Discusses trends in the use of Ni alloys in aviation, automotive industry, railroading, marine construction, welding, and oil industry. Tabulates percentage distribution of Ni in 1926 and 1934 and amount of Ni contained in the principal Ni alloys. MS (14a)

Silver for Chemical Equipment. C. H. S. Tupholme. *Chemical Industries,* Vol. 36, June 1935, pages 527-528. A discussion of the corrosive action of many reagents on Ag. RAW (14a)

Bronze, Its Use as a Forming and Drawing Die Material. J. D. Zaiser & G. K. Dreher. *Iron Age,* Vol. 136, July 25, 1935, pages 22-23, 78. Deals with the use of a bronze of the Cu, Al, Fe type for general die service. It is produced by the Ampco Metal, Inc. The alloy is produced with as-cast hardness up to 340 Brinell, measured under a 3000 kg. load. The advantages of Ampco metal dies are longer life, greater continuity of operation and better work appearance, and reduction of buffing and finishing costs. Articles made with Cu-base dies are automobile frames, oil line pipe, bumper guards, fenders, Zn battery cells, etc. These dies are not recommended for drawing Cu, brass or bronze, or for service with unpickled sheets. VSP (14a)

Recent Applications of Light Alloys in Motorcycle Construction (Su alcune recenti applicazioni delle leghe leggere nelle costruzioni motociclistiche). G. Piantanida. *Alluminio,* Vol. 4, Mar.-Apr. 1935, pages 92-94. Al and its alloys are extensively used in motorcycle construction for cylinder heads, pistons, and even engine blocks, when lined with steel, or cast-iron. The Cross (English) cycle uses a cylinder made of Aeral without any lining. AWC (14a)

British Pewter Developments. *Tin,* May 1935, pages 8-9. Modern pewter in new designs containing 96% tin has been successfully introduced in England and is expected to become popular elsewhere. BWG (14a)

Aluminum Castings for Monuments (Aluminium- Bildguss). *Giessereipraxis,* Vol. 56, July 7, 1935, page 283. Paper first gives a brief historical survey on application of Al for above mentioned purpose with special reference to American monuments. Such castings are generally made according to the wax melting process. Large monuments are subdivided, the single parts are individually molded and cast. To retard corrosion castings are subjected to a special process of surface treatment. GN (14a)

Use of Lead for Sound Insulation of Buildings (L'emploi du plomb pour isolant phonique des locaux). *Génie Civil,* Vol. 106, June 22, 1935, pages 616-617. Sheets of lead even as thin as 0.5 mm. were found to be good insulators for the usual noises found in living quarters. A table of sound insulating properties of lead sheets of different thickness is given. With thin sheets the tension created by their application to the walls by means of glue greatly reduces their insulating power. A special arrangement for fastening sheets in this case is described. JDG (14a)

Air-Cooled Engine with Hard Aluminum Cylinder. *Automotive Industries,* Vol. 72, June 1, 1935, page 731. Tests started Feb. 25, 1935, on a hard (Ni-Al) air-cooled cylinder engine showed practically no piston wear and no trouble from overheating. With a larger cylinder and the same, or 6 to 1 compression ratio, some heat trouble developed. BWG (14a)

Chilled Cast Iron Tappets. *Automotive Industries,* Vol. 72, June 8, 1935, page 778. Abstract from "Cast Iron Founding in the Automotive Industries." Francois Thivot, Journal French Society of Automotive Engineers, Dec. 1934. Valve tappets of chilled cast iron have given complete satisfaction in use and proven themselves superior to the best steel tappets. Two different types are illustrated. The surface subjected to frictional wear is quenched immediately after pouring. BWG (14a)

14b. Ferrous

M. GENSAMER, SECTION EDITOR

Lightweight Steel Units Are Used in Novel Structure. E. A. France, Jr. *Steel,* Vol. 97, July 15, 1935, pages 51-52. Describes house designed by Walter H. Stulen in conjunction with American Sheet & Tin Plate Co. Units used for walls, floor, and roof are formed out of 3 small rolled or pressed steel angles, placed parallel, to which 16-gage Cu-bearing sheets, pressed into standard shapes are spot welded. Sheets are given a slight bend from top to lower corners before welding. Sheet units appear as diamond shapes on flat pattern drawing, there being 4 to the square yard. There is a considerable saving in weight over solid building members. Units are usually field welded into place. Insulation can be easily attached and any desirable material may be used for exterior finish. MS (14b)

Non-Porous Steel Developed for Cold-Header Dies. George Ehrnstrom, Jr. *Iron Age,* Vol. 135, June 27, 1935, pages 32-33. Describes development by the Jessop Steel Co. The cold-header steels developed are water-hardening C and C-V steels with correct depth hardening characteristics. An improved method of pouring whereby the separation and removal of center of ingot in which inclusions and segregations are found is of importance in production of non-porous steel. Proper heat treatment giving headers good case depth and hardness is also important. VSP (14b)

The Growler Becomes Respectable. George Ehrnstrom, Jr. *Iron Age,* Vol. 136, July 4, 1935, pages 28-29. Deals with the use and advantages of dispensing beer in cans. Saving in volume in the can over the bottle is claimed to be 65%; the saving in weight 55%. American Sheet & Tin Plate Co. has developed an unusually stiff, ductile tin plate for the purpose. The 107 lb. stock is thus far the most suitable for can manufacture. VSP (14b)

Chromium Alloy Steel. *Steel,* Vol. 97, Aug. 5, 1935, pages 34-35. Rustless Iron Corporation of America has had constructed a hopper car and a merchandise container using its new rustless, high-strength RR-II steel. Car has an underframe of high-tensile steel castings. It is claimed that the body will not require replacement during the life of the underframe. Ratio of revenue load to total weight is 81%. Preferred composition of new steel includes more than 11% Cr and 0.05-0.07% C. It may be used within a wide range of physical values—70,000-150,000 lbs./in.^{2} tensile strength. Typical values are: ultimate strength, 90,000 lbs./in.^{2}; yield-point, 65,000 lbs./in.^{2}; elongation in 2 in., 15-25%; hardness, 185 Brinell; and Izod impact, 90 ft.-lbs. Where appearance is secondary, alloy may be placed in service without painting. It is unusually resistant to abrasion and can be hot and cold worked, machined and welded. Temperatures most suitable for hot forging and pressing are 1500°-2200° F. To facilitate subsequent shearing, punching, or machining, it may be desirable to temper by heating for a short time at 1100°-1400° F. and air cooling. Shielded arc method of welding, using flux coated electrodes of about same composition as parent metal, is recommended. Small rivets of the steel may be driven hot or cold, while larger sizes usually are hot driven. In single shear, these rivets have a shear value over 75,000 lbs./in.^{2} Rivets must not be heated above 2250° F. MS (14b)

Large Uses of Steel in Small Ways. No. 292. Stacking Boxes. *Steel,* Vol. 97, Aug. 5, 1935, page 48. About 30,000 tons of steel sheets are used annually in the fabrication of stacking boxes used in handling and storing of small parts in manufacturing plants. Generally, boxes are supplied with an unfinished steel surface. Where corrosion is likely to occur, galvanized steel is used. MS (14b)

Large Uses of Steel in Small Ways. No. 291. Residential Elevators. *Steel,* Vol. 97, July 22, 1935, page 41. Describes steel elevator of recent design. MS (14b)

Large Uses of Steel in Small Ways. No. 289. Hose Clamps. *Steel,* Vol. 96, June 24, 1935, page 42. Manufacture of hose-clamps involves consumption of more than 1500 tons of steel annually. More popular type is made from galvanized or Cd plated cold-rolled strip steel. Automotive industry is largest single market. Heavier clamps, such as those used on railroad equipment, are frequently malleable castings. MS (14b)

Large Uses of Steel in Small Ways. No. 290. Spray Equipment. *Steel,* Vol. 97, July 8, 1935, page 40. Equipment for spraying paint and enamel requires annually a fair tonnage of various steel products in its manufacture. Guns are made principally of bronze and Al. In latest types, fluid nozzles and needle-valves are of stainless steel, about 15 tons being used for this purpose annually. Pressure tanks are of galvanized seamless drawn steel. Portable units are mounted on pressed steel bases or trucks. Booths are of galvanized steel sheets and steel angles. MS (14b)

Manufacture of Warm Air Heating and Air Conditioning Unit Requires Care. *Steel,* Vol. 97, July 22, 1935, pages 38-39. Outlines methods of Furblo Co., Hermansville, Mich. Cold-rolled steel is used for outer casing and access door. Blower sheave, motor pulley, impeller wheel hub, and set collars are cast of high-Si gray Fe. MS (14b)

Stainless Steel Strip Used for Furnace Conveyor Belts. *Steel,* Vol. 97, Aug. 12, 1935, page 49. Allied Products Corp., Detroit, Mich. uses 17% Cr stainless steel strip for conveyor belts in continuous furnaces for heat treating bolts and cap screws. Belts are 53 ft. long and are made from single strips. Total hearth length in each furnace is 15 ft. There are 2 hardening furnaces, maintained at 1600° F. One is fired with city gas and the other with fuel-oil. Drawing furnaces are fired with city gas and are operated at 600°-1400° F. MS (14b)

Unit-Type Steel Frame for Residences Introduced on Pacific Coast. *Steel,* Vol. 97, July 8, 1935, pages 34-35. Describes prefabricated house developed by Unitype Builders, Los Angeles. Standard structural steel members are shop welded into sections and delivered to job, where units are assembled quickly and connections are field welded. MS (14b)

Selecting Gearing for Cranes for Steel Mill Service. S. L. Crawshaw. *Steel,* Vol. 97, July 29, 1935, pages 30-31. Based on standards of Westinghouse Elec. & Mfg. Co. Wherever possible, forged steel should be used. Where castings are unavoidable they should be of 0.35-0.45% C steel, thoroughly normalized. All motor pinions and gears should be normalized and heat treated. All other pinions and gears should be normalized, heat treated and hardened. For the former group, the hardness is kept at a point where finish machining can be accomplished after heat treatment. For the hardened group, a combination is recommended to give maximum wear with maximum shock resisting qualities. Tabulates estimated physical properties and recommended toughness for gear teeth. MS (14b)

Gears Manufactured into Transmission Assembly for Quiet Operation. *Steel,* Vol. 97, July 1, 1935, pages 30-33. **Gears for Buick.** *Heat Treating & Forging,* Vol. 21, July 1935, pages 319-321. Describes procedure of Buick Motor Co., with chief attention to machining and finishing. To insure that gears are clean and free from scale prior to final lapping of teeth, they are hardened in cyanide, though not cyanided. Hardening baths are similar in arrangement to an automatic plating installation, with pre-heating, maximum temperature, and quenching temperature cyanide baths, and quench. Gears then go through a vertical automatic drawing oven. Cyanide produces a case 0.002"-0.003" deep. MS (14b)

High Tensile Steels for Structural Purposes. John Brunner. *Journal Society of Western Engineers,* Vol. 40, June 1935, pages 103-108. The results of physical tests on 3 high tensile steels for structural purposes are tabulated: (1) low-C, Cr, Si, Cu, P steel with high physical properties and abrasion-resistance qualities, and considerably better resistance to atmospheric corrosion than C steels. Analysis: C max. 0.10%, Mn 0.10-.30%, P 0.10-.20%, S max. 0.05%, Si 0.50-1.00%, Cr 0.50-1.50%, Cu 0.30-.50%. (2) a medium-C high-Mn, Si, Cu steel with high tensile properties and atmospheric corrosion-resistance qualities and atmospheric corrosion-resistance about equal to Cu-bearing C-steel. Analysis: C 0.20-.35%, Mn 1.20-1.70%, P max. 0.04%, S max. 0.05%, Si 0.15% and Cu min. 0.20%. (3) a medium-C, high-Mn, Si, Cr, steel with high tensile properties and good abrasion-resistance qualities, and atmospheric corrosion-resistance about the same as Cu-bearing C-steel. Analysis: C 0.20-.35%, Mn 0.90-1.50%, P max. 0.04%, S 0.05%, Si 0.60-.95%, Cr 0.30-.70%. Applications of each class are mentioned. WHB (14b)

Elaborate Conveyor Systems Set Up at Grand Coulee Dam Diggings. Alphonse F. Brosky. *Steel,* Vol. 97, July 22, 1935, pages 24-27. Includes description of manufacture of the equipment. Ferrous metals are used extensively for structural members and finished parts. MS (14b)

The Tool Steels, their Development and Use (Verktygsstaalen, deras utveckling och användning). Hj. Aaselius. *Blad för Bergshandteringens Vänner,* Vol. 22, No. 2, 1935, pages 51-95; discussion, pages 95-97. Gives the history of common tool steels, high speed steels, and hard metals. First Swedish production of high speed steel was in 1902 when Brinell produced steel with 10% W, 2-3% Cr, and 0.7-0.8% C, produced in an acid Martin furnace, adding Cr and W in the form of ore, and using a small amount of pyrite (about 3%) in the charge. Addition of CO was begun in 1912. Later, additions of V and Mo were used. The new tremonite steel with 30% Co and 20% W is still in the experimental stage; tests on this material that have come to the author's attention have always shown an unusual brittleness after tempering. Discusses heat treatment and fabrication of tools, and takes up the types of steel used for drills, cutting tools, stamping and punching dies, and in equipment for drawing rod, wire, tubes, for hot rolling and pressure casting. Drill steel is still predominantly plain carbon steel. Lately a steel with 1.0% C, 1.25% Cr, and 0.40% Mo has given good service in rock drills; it possesses high fatigue resistance. For very acid mine water a hollow drill steel with a thin lining of stainless steel has recently been brought on the market. Takes up stellite and the various types of sintered carbides developed during the last 10 years. BHS (14b)

Relation of Chemical Composition to the Rail Fissure Problem. Earnshaw Cook. *Transactions American Society for Metals,* Vol. 23, June 1935, pages 545-555. Data are presented showing the effects of winter temperatures and chemical composition on the fissuring effect in rails. Writer believes compositions should be balanced to show a lower weighted hardness index determined from composition. Suggests definite comparisons be made between present semi-killed, low Si steel and thoroughly deoxidized steel of forging quality, that shallow hardening, fine grained Al killed steels may prove more resistant to thermal strains and impact, that the virtues of inverted, hot-top ingots be examined, that mill practice as to finishing temperature and cooling rate to be designed to produce a refined grain and low thermal stresses. WLC (14b)

Alloy Steel for Turbine Blading. *Journal of Commerce, Shipbuilding & Engineering Edition,* May 30, 1935, page 2. The use of alloy steel for blading and particularly of "A.T.V." alloy steel on account of its combination of strength with non-corrodibility and resistance to erosion is discussed, and it is stated that turbines of over 8,000,000 H.P. are now in service, in whole or in part, bladed with this alloy. The Normandie is bladed throughout, for both fixed and rotor blading, with this alloy steel and a total quantity of 66 tons is required for such purposes. JWD (14b)

Mining Provides an Expanding Market for Steel. E. L. Rainboth. *Iron & Steel of Canada,* Vol. 17, Nov.-Dec. 1934, pages 91-94. The various forms in which steel can be used in mine operations are illustrated using an asbestos mine as an example. Ha (14b)

Stainless Steel Facts. F. R. Widmer. *Sheet Metal Worker,* Vol. 26, Feb. 1935, page 82. Uses of stainless steel 18/8 by sheet steel men are enumerated and brief suggestions on fabricating methods given. Ha (14b)

Cast Iron in Machine Construction. John D. Watson. *Machinery,* London, Vol. 46, July 18, 1935, pages 488-490. General article on effect of Ni in reducing chill and making machinable castings. Strengthening of castings by addition of Ni and hardening by heat treatment are discussed. Comparative corrosion values are given for Ni cast-iron and ordinary cast-iron. WB (14b)

Selling Steel on Quality Is Best Service to Industry. John M. Watson. *Steel,* Vol. 96, June 3, 1935, page 17. From an address before eastern sectional meeting of American Society for Metals. Discusses use of steels in the automotive industry. MS (14b)

HEAVY SECTION CASTINGS
OF
CECOLLOY

A Synthetic Nickel Molybdenum Air Furnace Iron Alloy

For heavy section castings up to 60 tons, we have developed a series of iron alloys, known as "Cecolloy," with the following characteristics: Fine, homogeneous grain structure, 40,000 to 60,000 tensile strength, Brinell hardness which can be controlled in the furnace to suit the purpose of the castings, carbon content controlled within 0.05%, plus or minus. Cecolloy castings finish with a clean, smooth surface, the result of fine, graphite-free grain structure. Write for details.

CHAMBERSBURG ENGINEERING CO., Chambersburg, Pa.

Below is shown large CECOLLOY casting—cap for hydraulic press.

Ferrous Metallurgy in Aeronautics—A Complete Survey of the Qualities and Characteristics of Modern Steels for Aero Work. W. H. Hatfield. *Aircraft Engineering,* Vol. 7, May 1935, pages 113-125; June 1935, pages 143-152. Brief discussion of C steels, low alloy steels, nitriding steels, high tensile alloy steels, case hardening steels, valve, high thermal expansion, carbide cutting and stainless steels. Welding, machining, properties, contact-corrosion, internal stress and corrosion stress cracking reviewed. Applications of stainless steels and metallurgy of Aero steels are discussed at length with diagrams and micros to illustrate the text. Numerous data sheets are given for typical aircraft performance, strength-weight ratios of various materials together with physical properties. The physical and mechanical properties of structural steel, and rich alloy steel for aircraft construction are comprehensively tabulated. WB (14b)

Manganese Steel in Crushing Machines. W. B. Pickering. *Sands, Clays & Minerals,* Vol. 2, June 1935, pages 73-80. The superiority of Mn steel is due to the "work-hardening" on its face under the effects of a rolling, crushing or hammering action, and yet retaining the inherent toughness of the material in the body. Machinery is described. Ha (14b)

Applications of Nickel Alloy Steels and Cast Irons in the Tool and Die Field. J. W. Sands. *Machinery,* N. Y., Vol. 41, June 1935, page 592. A general appreciation of the value of Ni steels in various industrial fields. Ha (14b)

Materials for Glass Molds. *Glass Industry,* Vol. 16, June 1935, pages 180-181. Discussion of properties desired in metal molds and comparison of cast irons with alloy irons and steels. Two newly patented alloy cast irons, Silal and Nicrosilal, British Cast Iron Research Association, are compared with other materials with respect to grain growth and scaling. WB (14b)

Nickel-Clad Steel Varnish Kettle Bottoms. *Paint, Colour, Oil, Varnish, Ink, Lacquer Manufacture,* Vol. 4, Nov. 1934, pages 361. According to Allen neither Cu nor Al bottoms have a very long life in kettles or pots used for boiling the oil and gum in the manufacture of varnish. A material which satisfies the peculiar conditions to a fair degree was found to be Ni-clad steel. A 3/16" steel plate has a Ni-cladding amounting to 10% of the overall thickness. Service temperature of the special utilization under discussion is 315° C. EF (14b)

Cast-Iron Block Pavement at Wilmington, Del. *Engineering News-Record,* Vol. 114, Feb. 28, 1935, pages 317-318. New cast-iron block of American design is being tested on a short section of street which carries heavy truck traffic. Weight of cast-iron part is about 265 lbs./yd.^{2}. CBJ (14b)

Armco Crib Retaining Walls. *Engineering,* Vol. 139, May 31, 1935, pages 570-571. Illustrated article on the use of Armco iron for retaining walls. This material is advantageous for this purpose due to its lightness for transportation in comparison with concrete sections and construction is very rapid as the sections are standardized. Armco iron stands up well under exposure to the weather. LFM (14b)

15. GENERAL

RICHARD RIMBACH, SECTION EDITOR

The Working, Heat-treating and Welding of Steel. H. L. Campbell. John Wiley & Sons, Inc., New York, 1935. Cloth, 6 x 9¼ inches, 185 pages. Price $2.25.

This is an elementary text book used at the University of Michigan. Review questions follow each chapter and outline of 18 laboratory experiments are given. Besides the topics mentioned in the title, there are half a dozen pages on coating metals to resist corrosion. The experienced metallurgist will find nothing new in it, nor will it serve him as a reference book, but it is clearly and concisely written for the beginner. Aimed to be an introduction to engineering metallurgy, it hits its mark squarely, bringing out the essential fundamentals but stopping short of elaborating so much on them as to confuse the student. It should be an easy book to study and can be recommended either as a college text book or for home study. H. W. Gillett (15)—B—

Transactions American Institute of Mining & Metallurgical Engineers, 1934, Institute of Metals Division. Vol. 111. Published by the Institute, New York, 1934. Cloth, 6¼ x 9¼ inches, 379 pages.

Contains 22 papers on non-ferrous physical metallurgy, which have been covered in the abstracts, from preprints. The papers are about equally divided between crystal structure studies and information obtained by the older methods. One of the most interesting contributions is that by Fink and Freche in the correlation and generalization of data on the solid solubility of various alloying elements with pure aluminum. As usual, the discussions add much to the understanding of the papers, so that those who have read the preprints will now want to read the discussion as well. We wonder if the permanent value of metallurgical literature that is presented at technical society meetings would not be materially enhanced if fewer papers were read and more opportunity allowed for discussion. This is usually urged to make the meeting more interesting for those who attend, but it would be equally helpful for those who read the papers rather than hear them. H. W. Gillett (15)—B—

Strength of Materials. James E. Boyd. 4th Edition. McGraw-Hill Book Company, New York, 1935. Cloth, 6 x 9 inches, 548 pages. Price $3.75.

This is a civil engineer's text book, with full emphasis on the calculation of static stresses and almost none on the availability of materials of different strengths and properties. A.S.T.M. specification values for structural steel, cast steel, cast iron, wrought iron, naval brass, hard drawn and soft copper wire and values for a few aluminum alloys are given, but the student would not gather that there was any alloy steel other than nickel steel, nor that any steel could be heat-treated. There is a word on factors of safety, which, it is stated, should be large enough to take rusting into account, and the effect of local stress intensification is casually mentioned, but no mention of design based on the possibility of corrosion-fatigue or of the effect of threads, keyways, etc. Fatigue is mentioned and Moore's "rise of temperature" and "over night" accelerated tests are featured more strongly than Moore himself would be likely to do. A paragraph mentions the "crystallization" fallacy. Creep is defined as deformation above the yield point. The book deals with calculation of strength from size and shape but does not give an adequate picture of the modern materials of construction for anything save structures under static stress. Even in that field, the discussion of welded structures seems inadequate. Students must, of course, start in with just what the book contains, but it would take but a few pages more to steer them straight on various causes of failure and to introduce them to a wider choice of structural materials, so that it seems a pity that some one acquainted with the metallurgy of materials of construction did not collaborate.
H. W. Gillett (15)—B—

Textbook of Physical Chemistry. Surface Phenomena, Chemical Kinetics, Electrolysis. Vol. 5. (Lehrbuch der physikalischen Chemie. Grenzflächenerscheinungen, chemische Kinetik, Elektrolyse). K. Jellinek. Ferdinand Enke Verlag, Stuttgart, 1935. Paper, 6½ x 10 inches, 288 pages. Price 27 RM.

Various colloidal phenomena, adsorption, the dropping electrode, suspensions, the Brownian movement, peptization, etc., are treated. Mono-, bi-, and trimolecular reactions are dealt with, as are diffusion reaction velocity, and catalysis. The principles of electrolysis, overvoltage, passivity, and polarization in the latter part of the book and a brief discussion of atoms and electrons are the only portions having much direct connection with metallurgy.

The whole treatment is highly mathematical. It is a text book rather than a reference book. H. W. Gillett (15) -B-

Principles of Physical Metallurgy. Gilbert E. Doan. McGraw-Hill Book Company, New York, 1935. Cloth, 6 x 9 inches, 332 pages. Price $3.00.

This is a reprinting, with slight changes, of some parts of the book, Principles of Metallurgy, by Liddell and Doan, published in 1933, which included chapters on smelting. These are eliminated in the present book. Minor additions and a few late references have been added to the sections dealing with physical metallurgy.

Some practical examples are used to illustrate principles, but the effort is to deal solely with principles; the reader is referred to more detailed treatises for engineering data. It is essentially a college text book, and serves its purpose satisfactorily. H. W. Gillett (15) -B-

The Foundry Trade Journal, Vol. 52, Jan. 3, 1935. This number is devoted to a review of the Foundry Industry of 1934. AIK (15)

Activities of the Verein Deutscher Eisenhüttenleute in the Year 1934 (Aus der Tätigkeit des Vereins deutscher Eisenhüttenleute im Jahre 1934). *Stahl und Eisen,* Vol. 55, Feb. 7, 1935, pages 137-159. A good summary of the publications which have appeared in *Stahl und Eisen* and in the *Archiv für das Eisenhüttenwesen* during 1934 on the chemical and physical metallurgy of iron and steel. 100 references. SE (15)

15a. Economic

Potash and Aluminium Production from Alunite (Die Pottasche und Aluminium gewinnung aus Alunit). Bruno Waeser. *Die Metallbörse,* Vol. 24, Nov. 28, 1934, page 1513. Large deposits of alunite or $K(AlO)_3(SO_4)_2 + 3\ H_2O$ occur in Utah, Colorado, California and Georgia. Its commercial utilization was abandoned in 1924 and was resumed last year. The previous chemical processes are summarized and new trends in improving the economy of the commercialization of alunite are discussed. The author holds that the devaluation of the dollar and high tariffs are the greatest help to the utilization of alunite in competition with Bauxite and potash industry. EF (15a)

Cadmium Industry in 1934—Advance Summary. H. M. Meyer. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 366, Apr. 30, 1935, 1 page. Production of metallic Cd in the U. S. in 1934 was 2,777,384 lbs., an increase of 22% over 1933. The Cd content of compounds manufactured was 566,700 lbs., an increase of 41%. AHE (15a)

Zinc Industry in 1934—Advance Summary. H. M. Meyer. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 352, Mar. 8, 1935, 3 pages. Production of distilled and electrolytic Zn in the United States in 1934 was 383,281 short tons, value $32,962,000, increase of 14% and 16%, respectively, over 1933. Stocks increased 13%. AHE (15a)

Lead Industry in 1934—Advance Summary. H. M. Meyer. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 359, Apr. 16, 1935, 3 pages. In 1934, the output of refined primary Pb in the United States from domestic ores was 299,841 short tons, worth $22,188,000, an increase of 15% in quantity and in value. About 34% of this Pb was from Missouri, 24% from Idaho, and 19% from Utah. The production of refined primary Pb from foreign ores, chiefly Peru, Newfoundland, and Canada, was 11,395 tons, a decrease of 18%. AHE (15a)

Rolled Zinc in 1934—Advance Summary. H. M. Meyer. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 367, May 8, 1935, 2 pages. The output of rolled Zn in the U. S. in 1934 was 40,916 tons, valued at $6,201,000, a decrease of 1% in quantity and an increase of 2% in value over 1933. AHE (15a)

Cost of Producing an Ounce of Gold—A Graph to Facilitate Comparisons. C. N. Schuette. *Engineering & Mining Journal,* Vol. 136, Apr. 1935, page 177. WHB (15a)

Value of Mineral Products of the United States, 1931-1933, by States—Summary. M. B. Clark. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 356, April 11, 1935, 1 page. AHE (15a)

Dominion Gold. John B. DeMille. *Engineering & Mining Journal,* Vol. 136, Apr. 1935, pages 175-177. At least 23 mills are expected to start this year, and perhaps there will be 100 mines producing by Jan. 1936.
WHB (15a)

Aluminum (Aluminium, ein deutscher Werkstoff). A. Dederer. *Aluminium,* Vol. 17, Mar. 1935, pages 127-130. The rapid extension of Al in industrial and household appliances and domestic supply of raw material and import of Al scrap is reviewed and statistics on consumption and production given. HA (15a)

Aluminum Industry in 1934—Advance Summary. H. W. Davis. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 349, Mar. 8, 1935, 3 pages. New Al produced in the U. S. in 1934 amounted to 74,177,000 lbs., value $14,094,000, compared with 85,126,000 lbs., value $16,174,000 in 1933. World production is estimated at 169,000 metric tons, an increase of about 19% over 1933. Uses are reviewed. AHE (15a)

The Canadian Mining Industry. George Howard Ferguson. *Mining Journal, Centenary Number,* 1935, pages 176-177. A review. AHE (15a)

Gold and Silver. J. P. Dunlop. *United States Bureau of Mines, Statistical Appendix to Minerals Yearbook,* 1934, pages 409-434. Final figures for 1933. AHE (15a)

Manganese Ore Industry in 1934—Advance Summary. H. W. Davis. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 371, May 15, 1935, 4 pages. Shipments of domestic Mn ore containing 35% or more of Mn were 26,514 long tons, averaging 43% Mn, valued at $571,748, compared with 19,146 tons of 45% ore valued at $466,285 in 1933. Montana (43%), Georgia (24%), and Arkansas (22%) supplied 89% of the total shipments. Shipments of ferruginous Mn ore (10-35% Mn) from domestic mines were 23,231 tons, averaging 22% Mn, valued at $108,272, compared with 12,779 tons of 26% ore valued at $57,837 in 1933. Montana (48%) and Georgia (40%) supplied 98% of the total. Shipments of domestic manganiferous Fe ore were 198,591 tons, averaging 7.7% Mn, and valued at $512,818, compared with 178,852 tons of 7.8% ore, valued at $471,367 in 1933. Minnesota supplied virtually all of this. AHE (15a)

Mineral Prospects in Tanganyika. B. E. Frayling. *Mining Journal, Centenary Number,* 1935, pages 112-113. A review. Au is the principal metal of value. AHE (15a)

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Magnesium Industry in 1934—Advance Summary. A. E. Davis. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 365, Apr. 30, 1935, 2 pages. Mg ingot sold or used in the United States in 1934 was 4,249,838 lbs., an increase of 196% over 1933. AHE (15a)

Sintering Conserves Our Iron Ores. Edward J. Fournier. *Compressed Air Magazine,* Vol. 39, Feb. 1935, pages 4345-4347. The available supply of high-grade Fe ore in this country does not exceed 7.5 billion long tons, which at the 1926 consumption rate will be exhausted in 125 years. Potential blast-furnace material is unofficially estimated at 10 billion tons. Attention is directed to the sintering of Fe bearing ores in powdery form or of high moisture content and the utilization of blast furnace flue dust by the same process is discussed. There are 285 Fe blast furnaces in the U. S. A. and of these only 50 are equipped with sintering plants. WH (15a)

The Mineral Production of India During 1932. L. L. Fermor. *Records of the Geological Survey of India,* Vol. 67, part 3, Sept. 1933, pages 249-327. Statistical. AHE (15a)

Aluminum and Bauxite. Cyril S. Fox. *Mining Journal, Centenary Number,* 1935, page 46. The establishment and rise of the Al industry are reviewed. AHE (15a)

The Minerals of New South Wales. A. E. Heath. *Mining Journal, Centenary Number,* 1935, page 169. A review covering Au, Ag, Pb, Zn, Cd, Sn, W, Mo, Cu, Fe, etc. AHE (15a)

Gold, Silver, Copper, Lead and Zinc in California. F. W. Horton & H. M. Gaylord. *United States Bureau of Mines, Statistical Appendix to Minerals Yearbook,* 1934, pages 179-197. Final figures for 1933. AHE (15a)

Tungsten Industry in 1934—Advance Summary. Frank L. Hess & H. W. Davis. *United States Bureau of Mines, Mineral Market Reports,* No. M. M. S. 373, May 24, 1935, 1 page. In 1934, 2,049 short tons of domestic concentrated W ore (reduced to 60% WO_3 equivalent) were sold, compared with 895 short tons in 1933. AHE (15a)

The Mineral Resources of the Gold Coast. Wm. T. James. *Mining Journal, Centenary Number,* 1935, pages 117-118. Au, Mn and Al are the chief metals of the Gold Coast. AHE (15a)

Iron and Steel Imports of the Argentine. St. G. Irving. *Iron & Coal Trades Review,* Vol. 130, June 28, 1935, pages 1102-1103. Statistics on finance, trade, production, industrial conditions and labor are given and the growing industrialization in steel and tin plants in the country is commented on. Ha (15a)

Victoria's Record. Richard Linton. *Mining Journal, Centenary Number,* 1935, page 170. Statistical. AHE (15a)

Gold. H. N. Lawrie. *Mining Journal, Centenary Number,* 1935, pages 26-28. World production, technical progress, and various monetary considerations are discussed. AHE (15a)

Iron and Steel: A Century of Expansion. William J. Larke. *Mining Journal, Centenary Number,* 1935, pages 49-50. A review. AHE (15a)

The Mineral Production of India During 1933. L. L. Fermor. *Records of the Geological Survey of India,* Vol. 68, part 3, Sept. 1934, pages 251-336. Data are given on Sb, chromite, coal, Co, Cu, Au, ilmenite, Fe, Pb, Mn, monazite, Ni, Ag, Sn, W, Zn, bauxite, Bi, refractory materials, and nonmetallics. AHE (15a)

Gold, Silver, Copper, Lead, and Zinc in Arizona. C. N. Gerry & T. H. Miller. *United States Bureau of Mines, Statistical Appendix to Minerals Yearbook,* 1934, pages 153-178. The final report for 1933. AHE (15a)

Indian Gold Mines. *Mining Journal, Centenary Number,* 1935, pages 134-135. A review of the achievements on the Kolar goldfield. AHE (15a)

Australian Mining—Past, Present, and Future. *Mining Journal, Centenary Number,* 1935, pages 152-153. A review. AHE (15a)

Malaya: The World's Greatest Tin Field. *Mining Journal, Centenary Number,* 1935, pages 138-139. Economic. AHE (15a)

Iron and Steel in India. *Mining Journal, Centenary Number,* 1935, pages 131-132. A review. AHE (15a)

The Potentialities of the Indian Mineral Industry. *Mining Journal, Centenary Number,* 1935, pages 128-129. A review. AHE (15a)

Canada. *Mining Journal, Centenary Number,* 1935, pages 177-178. Statistical. AHE (15a)

New Zealand. *Mining Journal, Centenary Number,* 1935, pages 172-173. A review. AHE (15a)

LFM (15b)

15b. Historical

Technological Achievements. *Engineer,* Vol. 159, June 7, 1935, page 604. From a paper read by Sir Frank Smith before the Society of Engineers entitled "Some Significant Technological Achievements of the King's Reign." He reviewed the development made in steel cutting tools during the last 25 yrs. LFM (15b)

Cornwall Through the Century. E. H. Davison. *Mining Journal, Centenary Number,* 1935, page 187. A review. AHE (15b)

Light Metals and Their Alloys. William M. Corse. *Industrial & Engineering Chemistry,* Vol. 27, July 1935, pages 745-751. A brief presentation of the history of the discovery, development, uses, present production and cost of Al and Mg and of their alloys. MEH (15b)

A Birmingham Nickel Alloy Works. *Engineer,* Vol. 159, June 7, 1935, page 592. Illustrated article describing machinery and processes used at the works of Henry Wiggin and Company, Limited, a concern started 100 yrs. ago.

MANUFACTURERS' LITERATURE

Steam Drop Hammers

Bulletin 255 discusses the Chambersburg Model E Steam Drop Hammers. The advantages of these hammers, whose cylinders are made of Cecolloy, are listed. Chambersburg Engineering Co., Chambersburg, Penn. (A 522).

Polishing Machines

A portable model and a floor model of these new metallographic machines are described and illustrated in a pamphlet from Eberbach & Son Co., Inc., Ann Arbor, Mich.

Published by the same firm: "Electrolytic Machine" designed on the Unit Power-Contained System for effecting electrolytic deposits. (A 523).

Brass Flux

The features of this flux, for uses with brass and bronze mixtures having a melting point up to 1800 deg. F., are described in a leaflet which also contains instructions for its use. The Maluminum Co., Indianapolis, Ind. (A 524).

Barrett Fusion Furnace

This furnace which was designed especially for coal ash fusions, and other high temperature work up to 3000 deg. F. is described and illustrated in a bulletin of the Burrell Technical Supply Co., 1936 Fifth Ave., Pittsburgh, Pa. (A 525).

Rotary Hearth Furnace

Bulletin 133-2 is devoted to this furnace which the manufacturer claims offers an economical means for maintaining continuous production, uniformity of temperature and a definite time cycle. Philadelphia Drying Machinery Co., Philadelphia, Pa. (A 526).

Tensile and Bend Testing Machine

A well illustrated folder is devoted to the new portable Airco machine which can be carried to the welding job so that the welded specimens can be tested rapidly and easily. Advantages from the use of this machine and instructions for operating it are included. Air Reduction Sales Co., New York, N. Y. (A 527).

Silvery Mayari Alloy Iron

Booklet No. 54-B contains pertinent facts for foundry and other users of this alloy, a natural nickel-chromium iron with high silicon content. It also gives essential information to users of foundry products. Bethlehem Steel Co., Bethlehem, Pa. (A 528).

Madison-Kipp

A folder gives information on the 4 main divisions of this company's services: die casting machines; die castings; lubricators and air tools. Well illustrated. Madison-Kipp Corp., Madison, Wis. (A-529).

Aluminum Alloy Castings

An attractive booklet contains interesting information on selection, mixing, melting practice, molding practice for sand castings, permanent mold castings, heat treatment, etc., of these alloys. Illustrated. Arthur Seligman & Co., Inc., New York, N. Y. (A 530).

Temperature Measuring Instruments

This folder contains illustrations and brief descriptions of the more popular types of "Alnor" instruments which, according to the manufacturer, will pay for themselves in the saving of fuel, reduction of scrap losses and improved products. Illinois Testing Laboratories, Inc., Chicago, Ill. (A 531).

New Methods for the Metallurgist

Are discussed in the publication "Waco Service" which is devoted to micro-optical equipment. Wilkens-Anderson Co., Chicago, Ill. (A 532).

The Empire Sheet

Contains information on Empire electrical sheet steel. Black Beauty, which has a smooth, uniform surface coated with a satin-black finish and Wabik Metal, a vitreous enameling sheet are featured. Interestingly illustrated. Empire Sheet & Tin Plate Co., Mansfield, O. (A 533).

Brass, Bronze and Iron Alloys

A colorful catalog containing engineering data, specifications and applications of these alloys in industry, has been published by the Cramp Brass & Iron Foundries Co., Philadelphia, Pa. (A 534).

The Jetal Process

Simple immersion in an aqueous bath for about 5 minutes colors all grades of common iron or steel a brilliant and uniform jet black. The manufacturer claims that this finish does not alter the dimensions of the articles and cannot chip, scale, peel or discolor. Alrose Chemical Co., Providence, R. I. (A 535).

X-Ray and the Foundry

Interesting treatise on this subject setting forth how the X-Ray has now come to the fore as a tool of the testing laboratory. Kelley-Koett Mfg. Co., Inc., Covington, Ky. (A 536).

Look to the Ingot for Quality in Steel

Booklet on the subject indicated, illustrating and describing ingots. Gathmann Engineering Company, Baltimore, Md. (A 537).

Vanadium Facts

A colorful, well illustrated publication containing news about modern alloy steels, irons and other metals is put out by the Vanadium Corp. of America, New York, N. Y. (A 538).

Gases for Controlled Atmosphere Furnaces

A bulletin which discusses the advantages offered by liquefied petroleum gases, the two in principal use being propane and butane, has been issued by The Philgas Dept. of Phillips Petroleum Co., General Motors Bldg., Detroit, Mich. (A 539).

"Nothing is Impossible to Industry"

Leaflet descriptive of complete units for oil or gas using special composition cast pots. The Campbell-Hausfeld Co., Harrison, O. (A 540).

Duraloy

The various types of Duraloy are described and physical properties and working data given, in a colorful leaflet. The Duraloy Company, Pittsburgh, Pa. (A 541).

Dark Field Optical Systems

A practical discussion of the subject is presented in an attractive, illustrated booklet. Bausch & Lomb Optical Co., Rochester, N. Y. (A 542).

Phosphor Bronze

Booklet giving full information regarding this alloy which is a true bronze of copper and tin with the addition of phosphorus, and, in the case of bearing metal, of lead as an anti-friction ingredient. The Phosphor-Bronze Smelting Co., 2200 Washington Ave., Philadelphia, Pa. (A 543).

Metallurgy of Wire Manufacture

This paper contains valuable and interesting data and was presented by H. W. Graham, general metallurgist of Jones & Laughlin Steel Corp., Pittsburgh, Pa. (A 544).

Hold-Heet Pyrometers

Wall type and Lance type are described and illustrated in Bulletin No. 202. Russell Electric Co., 339 W. Huron St., Chicago, Ill. (A 545).

Steel Treating

"Steel Stamina" contains articles of interest to steel treaters. Attractively illustrated. Lindberg Engineering Co., 218-24 Union Park Court, Chicago, Ill. (A 555).

Chapmanizing

Bulletin describing process for hardening low carbon steel, what it is and what it does. Illustrated. Chapman Valve Mfg. Co., Indian Orchard, Mass. (A 556).

Houghto-Clean

Interesting booklet containing a brief outline describing the use of the Houghto-Clean series of cleaning materials for metal working plants. E. F. Houghton & Co., Philadelphia, Pa. (A 557).

Alumite Plast-O-Fractory

Bulletin 26, Series A, contains directions for using and recommended applications for this refractory material in plastic, moldable form. Illustrated. The Massillon Refractories Co., Massillon, Ohio. (A 558).

Equipment Designs for the Pickle House

The advantages to be obtained by the use of Monel Metal in pickling equipment are set forth in an attractive booklet. The International Nickel Co., Inc., 67 Wall St., New York, N. Y. (A 559).

Electrode for Welding Cast Iron

This leaflet discusses "Ferroweld" which has a steel core surrounded by a heavy flux coating providing a shielded arc. Lincoln Electric Co., Coit Rd. & Kirby St., Cleveland, O. (A 560).

Lithorizing

Leaflet setting forth this process for making paint hold to galvanized iron. American Chemical Paint Co., Ambler, Pa. (A 561).

Free Cutting Brass Rods

Anaconda publication B-14, second edition, lists in detail the advantages of brass for screw machine products. American Brass Company, New York, N. Y. (A 562).

Atmospheres Controlled in New Furnaces at Auto Plant

This article by A. H. Allen, has been reprinted from "Steel" and is being offered by the Surface Combustion Corp., Toledo, Ohio.

Published by the same firm: "SC Special Furnaces in the Steel Industry," a leaflet illustrating some of the many special furnaces which are in service. (A 563).

Lectrodryer

A circular describing the "Pittsburgh Lectrodryer" which is used for drying gases used in connection with metallurgical heat treating processes is being distributed by this company. "Activated Alumina" is used as the adsorbent. Pittsburgh Lectrodryer Corp., Pittsburgh, Pa. (A 564).

Chemical Progress

A very attractive booklet, profusely illustrated, deals with the growth of this organization and gives interesting information regarding their products. The Dow Chemical Company, Midland, Mich. (A 565).

Welding Rod

A booklet telling about their Roman Bronze welding rod, and illustrating some of its uses has been issued by the Revere Copper and Brass, Inc., New York, N. Y. (A 566).

The Moly Matrix

A discussion of the SAE 4100 series of steels is being carried on in this publication, with special reference to its possibilities as an answer to many important practical and economic problems. Climax Molybdenum Co., 500 Fifth Ave., New York, N. Y. (A 567).

Hydraulic Compression Testing Machine

Bulletin No. 88 discusses the Southwark-Emery 75,000-lb. machine which is suitable not only for 2 in. cubes and 2 by 4 in. cement cylinders, but for 3 by 6 in. concrete cylinders with a maximum of ¾ in. coarse aggregate, low strength cements, and low heat cubes at 1 or 7 days where little strength has developed. Baldwin-Southwark Corp., Philadelphia, Pa. (A 568).

Electric Furnace

The Sentry Model "Y" which is described in Bulletin 1019 is offered especially for small tools, whether hardened on a production or intermittent basis. Furnace specifications are included. The Sentry Company, Foxboro, Mass. (A 569).

Testing Machines

A very interesting pamphlet discussing the Amsler Hydraulic testing machines vs. lever type machines has been issued by Herman A. Holz, New York, N. Y. (A 570).

Rapid Moore Lectromelt Furnaces

Bulletin No. TC illustrates and describes patented lift and swing-aside-roof type quick top-charge electric melting and refining furnaces. Pittsburgh Lectromelt Furnace Corp., Pittsburgh, Pa. (A 571).

American Electric Furnaces

This catalog contains data on construction and operation. American Electric Furnace Co., 29 Von Hillern St., Boston, Mass.

Published by the same firm: "Juthe Gas Furnaces" are described in this illustrated catalog. (A 572).

Controlled Grain Anodes

Seymour Nickel Anodes are homogeneous in grain structure, according to a bulletin on the subject. The various available shapes are illustrated and some useful data are given at the back of the bulletin. The Seymour Manufacturing Co., Seymour, Conn. (A 573).

Grinding of Cemented Carbides

A handy manual has been prepared from information and photographs obtained principally from the various manufacturers of cemented carbides and tools. Carborundum Company, Niagara Falls, N. Y. (A 574).

Plating with Duozinc

Technical information on zinc-mercury plating is contained in this operating manual. R. & H. Chemicals Dept. of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. (A 575).

Thermalloy Castings

Bulletin 101 contains information on Ni-Cr castings for heat and corrosion resistance which are X-ray inspected. Electro Alloys Co., Elyria, Ohio. (A 576).

Bimetal

A simplified version of its manufacture, and the way it works is contained in this pamphlet. W. M. Chace Valve Co., 1615 Beard Ave., Detroit, Mich. (A 577).

Refractories and Crucibles

An attractive book gives an abundance of information on super-refractories, high temperature cements, Tercod crucibles and Electroloys. Electro Refractories & Alloys Corp., Andrews Bldg. Buffalo, N. Y. (A 578).

B & L Steel Shafting

This attractive leaflet states that you are assured of close adherence to size tolerances, concentricity and straightness, the maintenance of uniformity and freedom from imperfections in B & L Shafting. Bliss & Laughlin, Inc., Harvey, Ill. (A 579).

Nickel Manganese Steel Welding Rod

A circular giving suggestions for welding with their nickel manganese steel welding rod has been issued by the American Manganese Steel Co., Chicago Heights, Ill. (A 580).

Potentiometer Stabilog

Bulletin No. 194 gives full information on this temperature controller. Illustrated. The Foxboro Company, Foxboro, Mass. (A 581).

Thermit Welding

This new booklet describes this alumino-thermic process for the welding of heavy sections of ferrous metals. Metal & Thermit Corp., 120 Broadway, New York, N. Y. (A 582).

Ballentine Hardness Testing Machine

Bulletin No. 1A describes this dynamic indentation tester which has a wide range field and the added advantage of a hardness scale of definite physical units. Tinius Olsen Testing Machine Co., 500 No. 12th St., Philadelphia, Pa. (A 583).

Better Castings

Interesting information is contained in this publication which is distributed by the Niagara Falls Smelting and Refining Corp., Buffalo, N. Y. (A 584).

TAM Products

Leaflet descriptive of TAM metallurgical alloys. The Titanium Alloy Mfg. Co., Met. Alloy Div., Niagara Falls, N. Y. (A 585).

Core Plates and Pallets

Transite core plates are made of a specially treated asbestos and cement combination which has none of the objectionable features of the metal plates commonly used, according to the manufacturer. Johns-Manville, 22 E. 40th St., New York, N. Y. (A 586).

Design and Use of Tube Supports in Cracking Stills

This attractive booklet discusses the principles of tube support design and the selection of suitable alloy materials for the above service. Illustrated. The Calorizing Co., Pittsburgh, Pa. (A 587).

Special Atmospheres in the Heat Treatment and Brazing of Metals

A reprint of the above article by C. L. West, Research Engineer, is offered by The Electric Furnace Co., Salem, O. (A 588).

Hot Plates

The construction of these Multiple Unit Hot Plates which may be used for any work done on gas hot plates is described in this illustrated leaflet, HD 835. Hevi Duty Electric Co., Milwaukee, Wis. (A 589).

U S S High-Tensile Steels

Pamphlet describing high-tensile steels developed to meet the need of the transportation industry. United States Steel Corp., Pittsburgh, Pa. (A 590).

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Oil-Hardening Steel

A colorful leaflet contains information on Invaro, which is a non-shrinking, non-deforming, oil hardening steel. Firth-Sterling Steel Co., McKeesport, Pa. (A 591).

New Method Annealing

Pamphlet containing data on this method. Illustrated. Power curves, comparison of annealing costs, etc. The Bellis Heat Treating Co., Branford, Conn. (A 592).

Refractories

The manufacturers of Shamva Mullite claim it is a super-refractory because it has a definite high melting point, great resistance to sudden changes of temperature and other features. The Mullite Refractories Co., Seymour, Conn. (A 593).

Misco

Leaflet describing the above line of stainless heat resisting corrosion resisting alloys. Illustrated. Michigan Steel Casting Co., Detroit, Mich. (A 594).

Binocular Microscope

Bulletin No. 9 illustrates a number of new constructions in wide field instruments with special reference to an automatic multiple objective nosepiece. E. Leitz, Inc., New York, N. Y. (A 595).

Heat and Corrosion Resistant Alloys

Bulletin Cl-A illustrates a number of complex castings made from Q-Alloys which are recommended for pipe fittings, furnace parts, etc. General Alloys Co., South Boston, Mass. (A 596).

Centrifugal Compressors

Bulletin 386 is devoted to this company's Design 9 Compressors. Illustrated. B. F. Sturtevant Co., Boston, Mass. (A 597).

Durimet

Bulletin A is devoted to three grades of the above steel, which was designed primarily to resist the action of hot weak solutions of sulphuric acid. The Duriron Co., Inc., Dayton, O. (A 598).

Liquitol

Bulletin A1-16-A deals with the use of Liquitol for iron and steel castings and ingots. Alpha-Lux Co., Inc., 192 Front St., New York, N. Y. (A 599).

1935 Die Casting Models

A special reprint reports the progress automotive engineers have made with Zinc Alloy Die Castings, New Jersey Zinc Co., New York, N. Y. (A 600).

Stiffness Tester

Bulletin E-10133 is a technical description of Smith Tabor Model "A" Precision Stiffness Tester, for the scientific measurement of stiffness and resiliency. Wilson Mechanical Instrument Co., Inc., New York, N. Y. (A 601).

Electric Furnaces

A pamphlet describes the "Certain Curtain" furnace which was developed for positive furnace atmosphere control. It is designed for heat treating at temperatures between 1850 and 2500 deg. F. C. I. Hayes, Inc., Providence, R. I. (A 602).

Stainless and Heat Resisting Electrodes

A colorful price list and data book containing complete descriptions of the company's products and also analyses of stainless and heat resisting alloys manufactured by other companies has been issued by Maurath, Inc., Cleveland, O. (A 603).

Stainless Steel Castings

An attractive booklet contains useful information on the subject. Typical analyses, characteristics and suggested uses are listed. Joseph T. Ryerson & Son, Inc., Chicago, Ill. (A 604).

Spencer Turbo-Compressors

This bulletin which has illustrations of the complete range of sizes of this equipment also contains these new items: "Midget" Turbo for individual mounting, a single-stage line which effects new economies and Gas-Tight Turbos for acid and explosive gases. Spencer-Turbine Company, Hartford, Conn. (A 605).

Copperoid Steel Sheets

Leaflet illustrating and describing subject indicated. The Youngstown Sheet & Tube Co., Youngstown, O. (A 606).

Dolomite Refractories

This interesting pamphlet presents the case of Clinkered vs. Calcined Dolomite in the basic open-hearth steel furnace. Basic Dolomite, Inc., Hanna Bldg., Cleveland, O. (A 607).

Elfur Electric Furnace Iron Alloys

Bulletin setting forth data on Ni-Resist corrosion and heat resistant alloys particularly suited for locomotive wearing parts, Diesel engine parts, etc. Illustrated. Cramp Brass and Iron Foundries Co., Philadelphia, Pa. (A 608).

Properties of OFHC Copper

An attractive booklet contains reprints of three papers relating to the above subject. Photographs, diagrams and photomicrographs are used to illustrate them. United States Metals Refining Co., 420 Lexington Ave., New York, N. Y. (A 609).

Sonittep Products

A convenient looseleaf folder contains interesting facts on these products. Working data and applications of these products are given. Illustrated. George F. Pettinos, Inc., 1206 Locust St., Philadelphia, Pa. (A 610).

Industrial Furnaces

This catalog describes, illustrates and gives specifications for furnaces suitable for various applications. Mahr Manufacturing Co., Second and 18th Ave. N., Minneapolis, Minn. (A 611).

Refractory Cement

A leaflet pictures the results of a test performed on five brands of refractory cement which were trowelled on a tile and fired at 2700 deg. F. Charles Taylor Sons Company, 710 Burns St., Cincinnati, O. (A 612).

Mallory Elkon

Looseleaf catalog containing engineering data with descriptions, illustrations and recommendations for the selection of electrical contacts for all types of service. P. R. Mallory & Co., Inc., Indianapolis, Ind. (A 613).

Aerocase

Booklet on this subject. Illustrations, curve charts, tables. American Cyanamid and Chemical Corp., 30 Rockefeller Plaza, New York, N. Y. (A 614).

Furnace Bottom Refractory

A leaflet describing "Hearth-Crete" a chrome-base castable refractory for building monolithic bottoms in forging, bar, plate, angle, rolling mill and other steel heating furnaces has been issued by the Quigley Company, Inc., New York, N. Y. (A 615).

Wire Nails and Wire Products

A colorful booklet is devoted to the above subject. The different kinds of Republic wire are described, the nails and other products are illustrated and accompanied by tables giving the dimensions. Republic Steel Corp., Massillon, Ohio. (A 616).

Spectrometers and Accessories

Bulletin 133 describes and illustrates several different models of spectrometers which the manufacturers claim are rugged and accurate. Gaertner Scientific Corp., Chicago, Ill. (A 617).

Electromet Review

This publication whose purpose is to bring "News and Views of Alloy Steels and Irons" to the reader, contains interesting items. Electro Metallurgical Company, New York, N. Y. (A 618).

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METALS & ALLOYS

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Current News Items

Death of B. H. Johnson

B. H. Johnson, vice president of the American Foundrymen's Association and assistant to the president, R. D. Wood Co., Philadelphia, died in Toronto, Canada, Aug. 27. In addition to serving as vice president of A.F.A., Mr. Johnson was a member of several committees of the gray iron division of that organization. He had been a director of the A.F.A. and the representative of the Gray Iron Institute on the joint committee on foundry education in engineering schools. His technical training was acquired at the Mass. Ist. of Tech. After graduation, he went to work for Taylor & Gooding, engineers and machinists at Lynn. When that firm consolidated with the John T. Robinson Co. of Hyde Park, Boston, Mr. Johnson accepted the position of superintendent. In 1910 he became connected with the Cresson-Morris Co. of Philadelphia as works manager, and remained with that company for over 15 years. At the time of his death, he was associated with R. D. Wood Co., centrifugal cast iron pipe manufacturers, in Philadelphia.

Mr. Johnson was one of the organizers of the Gray Iron Institute (Cleveland) and was active in the work of that association, serving as president for one year. He was also an active member of the Philadelphia Foundrymen's Association, and the Metal Manufacturers' Association of Philadelphia.

Dr. Saklatwalla Resigns from Vanadium

Dr. B. D. Saklatwalla, Vice President and Director, Vanadium Corporation of America, has tendered his resignation to devote his main efforts to the formation of a new organization for research and development especially in connection with new steels and alloys and for rendering service of an advisory nature with the aid of expert associates in metallurgical and allied chemical fields. The especially novel feature of the contemplated organization will be its international scope as by suitable connections in foreign countries it is intended to correlate advancement along these lines in the various industrial countries of the world and to afford opportunity for exchange of developments rapidly taking place during the present reconstruction period. Dr. Saklatwalla is preeminently fitted for the undertaking having had a most successful career over a period of twenty-six years in the ferro-alloy and alloy steel industries starting from the very inception of these industries. He has to his credit inventions of various products and processes which are successfully operating on a wide commercial scale today. He is acknowledged an international authority on metallurgical subjects through his numerous publications and has been honored by institutions such as the British Iron and Steel Institute and by the award of the Grasselli Medal by the Society of Chemical Industry. Dr. Saklatwalla's connections in the foreign metallurgical world will also be an asset to the new organization as he has close connections in the various countries of Europe, his initial engineering and scientific training being acquired there. He has naturally contact with industrial developments in the Orient through his close family relation with the Tatas, the great steel masters and industrialists of India.

Changes in Republic's Personnel

R. J. Wysor, who has been vice-president in charge of operations of the Republic Steel Corp., Youngstown, Ohio, has been elected vice-president and general manager, a new title in the Republic organization. C. M. White, who has been Mr. Wysor's assistant, succeeds the latter as vice-president in charge of operations. B. F. Fairless, vice-president of Republic, has resigned to go with the United States Steel Corp.

John W. Carpenter, for 16 years district sales manager in the Cleveland, Ohio, territory for the Otis Steel Co., has joined the organization of **Republic Steel Corp.** as assistant manager of sales, sheet and strip division, according to announcement by N. J. Clarke, vice president in charge of sales for Republic. Mr. Carpenter's connection with Republic at its Youngstown, Ohio, headquarters took effect Sept. 1. A graduate of Princeton University, he served as first lieutenant in the U. S. Army during the World War and entered the steel industry immediately afterwards.

Airco Announces New Stores

On July 15, the Air Reduction Sales Co. moved from its long established location at Third and Glisan Sts. to larger quarters at 13 Northwest 4th Ave. in Portland, Ore., to provide more space to adequately stock, display and demonstrate Airco's complete line of oxyacetylene and electric welding and gas cutting equipment and supplies.

Because of the substantial growth of its business in Atlanta, Ga., and Tulsa, Okla., Air Reduction Sales Co. established on Aug. 1 its own company operated stores in these cities. In Atlanta, the new store is located at 336 Spring St., N.W., and in Tulsa at 18-20 North Cheyenne Ave. Airco apparatus, gas and electric supplies, oxygen, acetylene and other products will be stocked at these points.

Byers Broadens Activities to Make Steel Pipe

The A. M. Byers Co. has just announced to the trade the third major expansion project for this company in recent years. Several years ago Byers completed the largest and most modern wrought iron mill in the country at Ambridge, Pa., for manufacturing genuine wrought iron under their new process. Following this, the operations were further expanded to include the reintroduction of a wide range of wrought iron products which includes plates, sheets, merchant bars, angles, structurals, and forging billets.

Aluminum on Steel

Tinplate may soon have an active competitor in many of its uses, says *Business Week*. Prof. Colin Garfield Fink, head of the division of electrochemistry of Columbia University and secretary of the Electrochemical Society of the United States, has found considerable financial backing for his process of coating steel sheets with aluminum, a problem on which scientists have been working for some time without arriving at conclusively practical results. Professor Fink's process has now been approved by a large American company (neither a steel nor an aluminum producer), which may acquire the American rights. A German company, which has been interested in another process of achieving the same result, may abandon it in favor of the Columbia scientist's method.

Professor Fink's coating is said to be resistant to acids, so that it can be used in food containers. These will not be soldered; instead, an airtight seal will be used. The product is said to be appreciably cheaper than tinplate. As it is ductile, it may be used in automobiles and airplanes, and a wide application in the manufacture of sheets, rods, bars, and shapes is expected. In some cases, it may prove a substitute for aluminum.

Construction of the second branch plant of the **Young Spring & Wire Corp.,** of Detroit, to be located in the clearing industrial district, Chicago, has been completed. The Star Service Hanger Co., a subsidiary, has been located there since 1929. This is their ninth branch plant.

Nathan Hayward, president of **The Franklin Institute,** Philadelphia, has announced that Henry Butler Allen, metallurgist of the Henry Disston Co., Philadelphia, and member of the board of managers of the institute for several years, has been elected director of the museum as of Oct. 1. **Dr. Howard McClenahan,** who has been granted a year's leave of absence because of ill health, will continue as secretary of the institute, a position which he has occupied since he first came to Philadelphia in 1925.

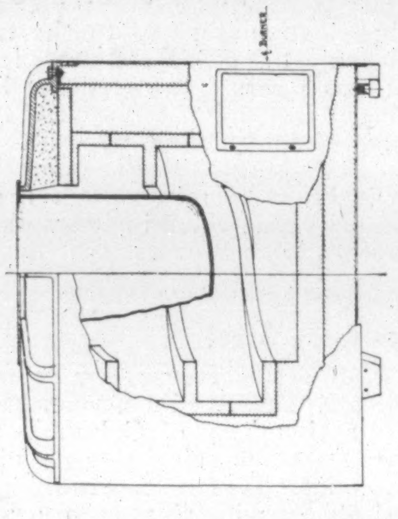
The **Maluminum Co.,** Indianapolis, Ind., manufacturers of foundry fluxes, announces that it has appointed **American Solder & Flux Co.,** Wayne Ave. and Berkley St., Philadelphia, as its factory representatives for Delaware, Maryland, Western New Jersey and Eastern Pennsylvania.

General Refractories Co., Philadelphia, announce the appointment of the **Chas. A. Strelinger Co.,** Detroit, as dealer agents in the Detroit area. The Strelinger company will carry a complete stock of refractories in addition to its well rounded line of industrial supplies.

New Equipment and Materials

A Screw Top Pot Furnace

The Lindberg "Screw Type Pot Furnace," Lindberg Engineering Co., 218 Union Park Court, Chicago, is built with the combustion chamber in the shape of an internal screw. Such construction forces the gases of combustion to circle the pot before leaving the heating chamber. With the usual pot furnace the flame travels once around the pot and exits at the flue. Due to this short flame travel the gases leave the furnace, not only at a high temperature, but generally not entirely burned as is evidenced by the flame observed at the flue. This method of firing is not only inefficient but results in comparatively short life of the pot due to uneven heating and flame impingement.



With the screw type pot furnace the flame travel is 2½ times as long as with former methods giving the gases opportunity for complete combustion. The burner fires entirely below the pot eliminating flame impingement and providing a perfectly uniform ribbon of flame on all sides and from top to bottom, thus eliminating the causes of premature pot failure. Tests on two furnaces exactly alike, except for the construction of the combustion chamber, show a saving in favor of the screw type of 45 per cent in heating from cold, 33 per cent in operation and an increase in production of 20 per cent. This new furnace is claimed to offer an obvious increase in efficiency in cyaniding, lead hardening and soft metal melting.

The Gray Milling Planer

A machine which is a combination of a milling machine, a planer, a boring machine and a drill and which can be used as a lathe is offered by the G. A. Gray Co., 3611 Woodburn Ave., Cincinnati. An outstanding feature is that the company has "developed a method of spotting heavy work in its 30-ton work table to an accuracy of less than 0.0001 in."—regarded as impossible until demonstrated. The machine is pointed to as one of great flexibility and general adaptability, as combining the speed of a milling machine with the accuracy and simplicity of the tooling of a planer. Without changing the setting of the job, one can plane or mill, bore or drill. Hence it greatly reduces set-up time as well as cutting time.

Free-Machining S.A.E. Alloy Steels

Patents were granted on July 30, 1935, to Frank R. Palmer and assigned to the Carpenter Steel Co., Reading, Pa., for free machining alloy steels containing selenium. The utility of selenium as a free machining element has been established during the past few years through its extensive use in 18-8 chrome-nickel stainless steel. It is now announced that this same selenium gives promise of successful use in practically all other types of iron and steel products.

Sulphur has been extensively used in low carbon non-alloy steels for many years and is quite familiar to the trade under the general name of "screw stock." It is well known that sulphur combines with certain metals in the steel (usually manganese) to form non-metallic sulphides which occur in the form of slag-like stringers in rolled or drawn bars. In high-sulphur steel the extent of this non-metallic matter is sufficient to discourage its use in high grade alloy steels which must be heat treated and are later subjected to severe service.

It is claimed that selenium is superior to sulphur as a free machining element in two important particulars. First of all, a given percentage of selenium does not produce nearly as much slag-like material as an equal percentage of sulphur so that the cleanness and the uniformity of the product is greatly increased. Secondly, selenium is claimed more potent in its free machining effects than sulphur so that a smaller percentage of selenium is required in order to produce the same free-machining effect. These two advantages combine to produce a steel which is very much cleaner and more uniform than would be a high sulphur steel, having the same machining properties.

It is further claimed that the presence of selenium does not interfere with the response of the material to heat treatment and it is anticipated that many applications will be found where free machining S.A.E. alloy steels can be satisfactorily applied.

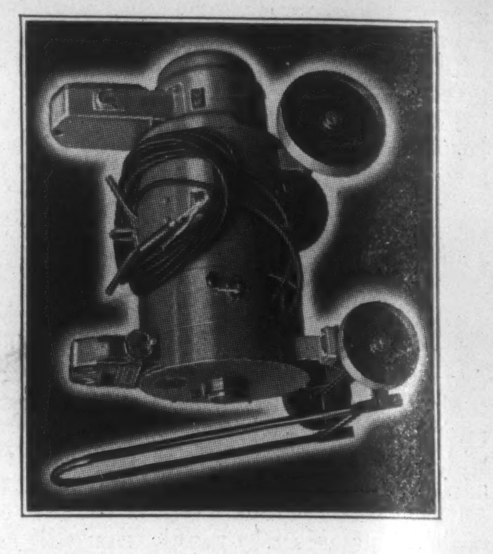
The experimental work described in these patents is extremely comprehensive, covering practically all S.A.E. types of analyses—both in the low-carbon carburizing grades and in the higher carbon tempering grades. It is further extended to cover many different types of alloy and plain carbon tool steel.

Offsetting the natural advantages that selenium has over sulphur as a free-machining agent, there appear to be two disadvantages. In the first place, celenium is more expensive than sulphur so that its use will doubtless be reflected in the higher price of the product. In the second place, all of the work done thus far has been on electric furnace melted steel which is rather conducive to higher quality than lower costs. It, therefore, seems likely that the applications of these new free-machining alloy steels will be somewhat selective and may, at least temporarily, be limited to the manufacture of parts in which the machining costs are relatively high compared to the weight of steel involved.

New Heavy-Duty Welder

A newly improved line of Heavy-Duty arc welders is announced by the Harnischfeger Corp., Milwaukee. The most important changes and refinements include the new oversize, two-bearing armature shaft, removable ball bearing capsules, more simplified single current control, dustproof calibration plate, heavy-duty built-in polarity switch and dripproof housings.

The new 200-amp. machine, illustrated, retains the previous P&H-Hansen generator design with the patented internal stabilizer coils imbedded in the main pole tips, unique short circuit winding and magnetic bridge which broaden the welding range and improve the uniformity of current. The general outward appearance of the 300 and 400 ampere units is identical.



Motors have solid cast frames with top opening for terminal leads and mounting of the magnetic switch-type starter. It is equipped with no-voltage release and overload protection; operated by push buttons. A constant flow of cooling air, circulated by the large aluminum fan between motor and generator, is discharged at the end of the all-welded generator housing. Connections are available for standard or special voltages of 2 and 3-phase, 60 and 50 cycles. Gasoline-powered units in a wide variety of stationary and portable mountings also are included in the new line.

Stripes and Patterns Now Available in Strip Steel

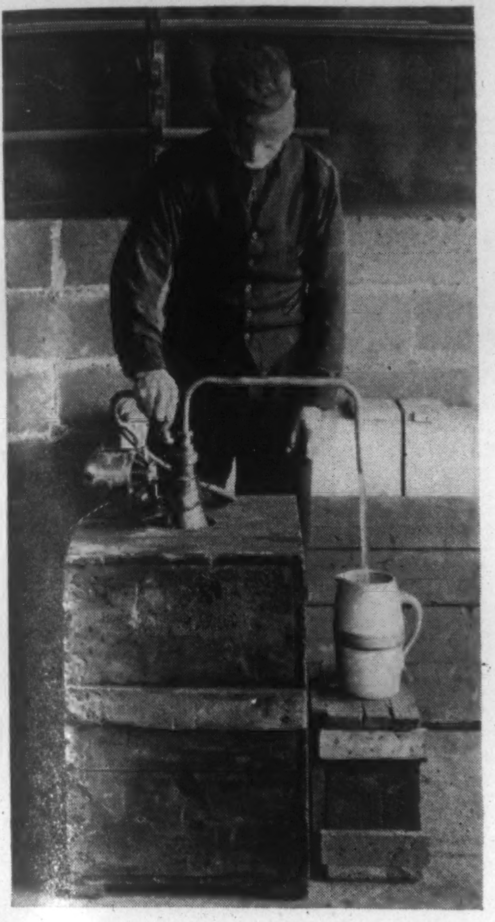
Strip steel in a new and attractive finish is now being marketed by Acme Steel Co., Chicago. "Satinstripe" is the name of this new type of finish, which is composed of stripes or patterns rolled into the steel by specially ground rolls. Acme states that Satinstripe is available in many different kinds of stripes, varying in width and depth. Even with the application of chrome, nickel or color finishes, the beauty of the design shows through clearly.

It is expected that Satinstripe will have wide application in providing both practical and smartly attractive finishes for a large number of different products. The "modern" appearance of this finish will undoubtedly see it used for products where the design is in the modern manner.

An Acid Ejector

The Lea Mfg. Co., Waterbury, Conn., offers an acid ejector for emptying acids and other liquids from carboys, for which it claims the following advantages:

(1) Prevents accidents; (2) handles the taking of acids from carboys by the safest method ever devised; (3) does away with tilters, cradles, blocks, etc.; (4) does away with nicked and broken carboys; (5) prevents the acid from destroying containers, a saving which in time will pay for the machine; (6) takes any quantity acid desired from carboys without tilting or lifting from the floor and can be handled by one man; (7) saves dollars in acid loss; (8) protects floors. No spilling of acid. Carboys of acid can be stored and used in doors. This is especially desirable in cold weather; (9) lowers insurance rates by reducing accidents; (10) endorsed by insurance companies and safety engineers.



Core Plates and Pallets

Advantages which may be gained by foundrymen and by the ceramic and abrasive industries through the use of J-M Transite core plates and pallets have just been set forth in a new booklet published by Johns-Manville. J-M Transite core plates are made from flat sheets of asbestos and portland cement combined under great pressure and then specially treated with a series of impregnations and bakings. They are economical because they are permanently non-corrodible (easier to clean), show little if any warpage after long service, and do not break or crack when dropped as easily as do plates commonly used. A very important consideration is that Transite core plates are lighter than steel or iron plates and a core maker can carry twice as many Transite plates with less effort.

J-M Transite pallets for the ceramic and abrasive industries are identical in composition with Transite core plates and are of special value in this type of work, not only because of their strength and resistance to warpage but because their smooth surface and low water absorption allow the ware to creep freely as it shrinks in the drying process.

Buick Has New Rust-Proofing Process

A new rust-proofing process, representing what is said to be the last word in providing protection for metal parts against corrosion and the action of the elements, has been installed and is in operation at the plant of the Buick Motor Car Co. The new Bonderizing process which employs the spray rather than the immersion method is the latest development of the Parker Rustproof Co. With it, all stamped metal parts and numerous other parts, including for instance coil springs for Buick's knee action, are protected prior to lacquering or enameling against rust and the effect of weather.

The process is a further development of the basic Bonderizing system, which consists intrinsically in giving the metal parts a phosphate crystalline coating which not only prevents corrosion under the finish but also prevents spreading of corrosion from accidental scratches which penetrate to the bare metal, thereby increasing life of finishes. Further, it is said to provide a better adhesive base for the application of the finishes themselves.

Among the advantages of the new spray process as installed at Buick are: (1) Greater rust-proofing efficiency and consistency, (2) ability to work with lower temperatures, (3) higher output for a given floor space, (4) higher rust-proofing output per dollar expended, (5) freedom from the carrying over of inert materials on the part being bonderized, (6) elimination of special alkaline chemical cleaning prior to bonderizing, preventing any chance of such cleaners neutralizing the bonderite solution; and (7) better working conditions for the operators.

The entire process from cleaning, through bonderizing, fixing, and drying is automatic, with parts carried through on two continuous conveyors. In all there are eight steps in the entire process which prepares the metal parts for the application of finishes, including six pressure-spray booths.

Berwick Electric Valve Stem Heater

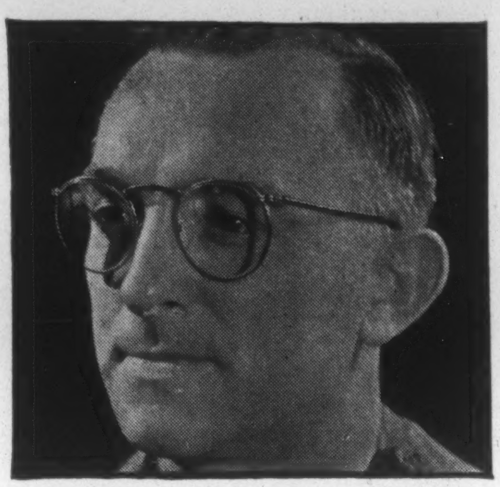
The new Berwick electric valve stem heater, a product of the American Car & Foundry Co., New York, gives an end-heat on practically any diameter rod on which the heat does not have to be more than once or twice the diameter. The temperature is determined by the use of the electric eye, which releases the jaws, causing the piece to drop into an oil-bath. This heater is also built with a delayed action for a soaking period. In other words, if you set your electric eye for 1700 deg., or whatever temperature you desire, when this temperature is reached, the electric eye starts an electric time-clock which holds the desired temperature over whatever number of seconds the clock is set for, before releasing the piece.

JETAL—An Excellent Bond for Subsequent Finishes

The new "Jetal Process" (patent applied for) recently developed by Alrose Chemical Co., Providence, R. I., is proving popular not only as a substitute for other black and oxidized finishes but for use on iron and steel as a bond for enamels, lacquer, japanning and other baked finishes. High temperatures do not affect this lustrous black finish nor are the dimensions of articles altered through treatment by the Jetal process. Jetal is a finish in itself. It is scratch-proof, will not chip, peel, scale or discolor.

New Goggle Made in Ful-Vue Style

A new goggle, exactly like the well-known Ful-Vue spectacles in its appearance and in many of its design features, has just been announced by American Optical Co., Southbridge, Mass. The chief advantages of the "F3100, Ful-Vue" goggle, as stated by the manufacturer, are its handsome appearance and its comfort. For the customary nose-piece, the new goggle substitutes pearl full-rocking nose-pads which distribute the slight weight of the goggle on the sides rather than on the top of the nose. Ear-pieces are of flexible cable, completely insulated, so that no metal touches the skin at any point. As on the popular Ful-Vue spectacle frames the ear-pieces are set high on the rims, removing every obstruction to full side vision and adding to the goggle's good looks. The new goggle is fitted with the new 6-curve super armorplate lenses, capable of withstanding blows approximately twice as heavy as those which fracture standard lenses. The domed surface of the lens is declared to be exceptionally effective in deflecting glancing blows. Lenses are shaped to fit closely to the eye without interfering with eyebrows or lashes.



Improved Stop-Off Lacquer for Chromium Plating

After many years of study and testing, the Research Laboratories of United Chromium, Inc., 51 East 42nd St., New York, have developed a new and superior stop-off lacquer, "Unichrome Resist" for use in chromium plating. It is claimed by the engineers of this company that this new stop-off lacquer possesses the following ideal properties to a higher degree than any other lacquer with which they are familiar:

(1) An excellent insulator from an electrical standpoint; (2) resistant to the chemical action of the various acids and rinse waters used in the cleaning and plating operations; (3) flows readily, air-drys quickly, and has good adhesive properties. Reasonably tough and ductile in addition; (4) readily removable by means of a solvent, when necessary, and readily applicable either by brushing, spraying or dipping; (5) when in contact with the chromium plating solution, does not yield any products which might contaminate the solution.

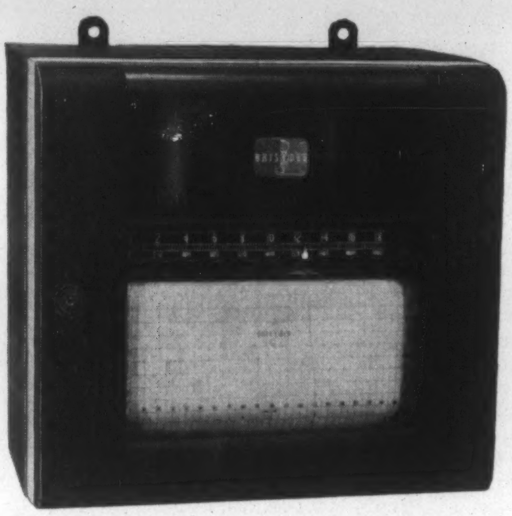
New Process for Cladding Ferrous Products

A process of cladding metals, which is claimed entirely new and which is offered under the name "Duo-Metals," is announced by the Latrobe Electric Steel Co., 40 East 40th St., New York (Works, Latrobe, Pa.) It is an electrochemical method for coating ferrous materials with stainless steel, high-carbon steel, high-speed steel, stellite or nickel. The process is fully protected by patents owned by P. A. E. Armstrong.

A New Potentiometer Pyrometer

The Bristol Co., Waterbury, Conn., announces, as an addition to its line of industrial instruments, "The Wide-Strip Pyrometer," available in single-record, multiple-record and recorder-controlled types. This instrument, operating on the potentiometer principle of temperature measurement, has a built-in accuracy that commands attention. This accuracy is made possible through an almost unbelievably simple measuring, balancing, and recording mechanism.

A stainless steel lead screw, operated by an electrical motor under the direction of two galvanometer-controlled contacts, adjusts the slide-wire contact and recording-pen unit to maintain e.m.f. balance in the potentiometer system. This mechanism introduces a new principle of operation into temperature measurement by means of the potentiometer method. The unique design of the balancing mechanism is such that all mechanical backlash is taken up, making it possible to magnify scarcely perceptible deflections of the galvanometer pointer. No clearance is required between the pointer and the chopper arms. Deflections smaller than 0.001 in. are easily measured.



The pen movement is always proportional to the size of the galvanometer deflection. This accounts for the quickness with which balance is restored and for the speed with which temperature changes are written on the chart.

The slide wire contact and recording pen are mounted on the same carriage. This particular feature simplifies the mechanical construction of the instrument and eliminates errors due to backlash, lost motion, etc., which are usually associated with gears, linkages, and other types of intervening connections used when slide wire and recording pen are not mounted integrally. The carriage on which is mounted the slide wire contact and recording pen runs on 4 wheels over a substantial 2-rail track, 3-point contact with the rails insures positive motion. It is driven through engagement with a hardened steel pin by a stainless steel lead screw. The lead screw, mounted on permanently lubricated ball bearings, is positively driven by an induction-type motor. There are no friction clutches nor ratchet mechanisms used. Exhaustive tests under actual plant conditions have proved that this instrument will give performance approaching ideality.

Hannifin "Hi-Power" Portable Hydraulic Riveter

The completion of an entirely new type of hydraulic production riveting machine comprising a portable yoke-type hydraulic press and an automatic hydraulic pressure generator, connected by high-pressure hoses and electric control cable, is announced by Hannifin Mfg. Co., 621-631 South Kolmar Ave., Chicago.

The portable yoke press weighs but 54 lb., and develops a maximum pressure of 35,000 lb., to head the rivet. This capacity is ample for ⅜-in. cold iron rivets. (By comparison, previous types of hydraulic presses of this capacity weigh approximately 300 lb). The throat of the yoke is 6 x 6 in., and the ram stroke 3 in. (A companion model press with a 4-in. reach weighs only 45 lb.) The maximum pressure developed on the dies may be adjusted to suit the work.

Control of the riveting operation is by a single push button at the top of the press handle. Depressing this button actuates the hydraulic pressure generating unit and its control valves, and the riveting cycle is completed automatically. The hydraulic pressure generator is a completely automatic power unit, with electrically actuated valves and oil pump control. It is driven by a 2 hp. motor, and the outside dimensions are 32 x 17 x 56 in., —less than 4 sq. ft. of floor space. The complete riveting cycle is 2½ sec. per rivet, and this speed is easily maintained. Handling of the portable yoke type press is remarkably simple.

With the high speed operation for which this riveting unit is designed, several special safety features are absolutely necessary. The design provides an inherent protection against a "repeat" stroke which is entirely automatic and extremely simple. There is also an instantaneous safety stop which is equally simple, and actuated by the natural reactions of the operator whenever it is required. The press will not repeat. When the control button is depressed and held down, the yoke press completes one cycle and stops. It is necessary to release the control button and depress it again to start the next cycle of operation.

The instantaneous safety stop operates at any point in the riveting cycle, so that the operator can catch and prevent the stroke if the rivet head is not in the die, or if the rivet is crooked in the hole, or if for any other reason should require stopping the press stroke. Merely releasing the control button reverses the ram and returns it to the starting position. The operator merely lets go, and the stroke is stopped.

New Oil-Proof V-Belt—The "Daycoil"

The first completely Oil-Proof V-Belt ever developed for general industrial use has been announced by A. L. Freedlander, vice-president and factory manager, the Dayton Rubber Mfg. Co., Dayton, Ohio. "The new belt will be marketed under the name 'Daycoil.' Its principal field of application will be the machine tool and other industries where excessive oil in connection with power transmission has long been a problem," Mr. Freedlander said.

"The 'Daycoil' V-belt is an advanced step in chemical and power transmission engineering and was developed over a period of years. The Dayton Rubber Mfg. Co., the world's largest manufacturers of V-belts, has pioneered in the development and marketing of synthetic rubber products. During the past five years the company intensified its efforts in the development of the uses of synthetic rubber, first experiments having been started many years ago.

"The 'Daycoil' V-belt carries the same laminated construction principles as the regular Dayton cog-belts for general transmission applications, plus, however, the specially designed casing of the new synthetic compound to resist oil."

New Way of Mounting Metals for Microscopic Analysis

Metallurgists and geologists are quite frequently confronted with the problem of mounting metal specimens which are to be examined microscopically. Specimens like small wires, sheets, springs, or powders, or any other small parts, have to be mounted for obvious reasons. Other specimens may be mounted to prevent curvature of the field where the mounting serves as a support. Still other samples should be mounted because a standardized shape will greatly facilitate uniform pressure during the grinding and polishing process.

Several research laboratories have recently perfected a new method of mounting small specimens in Bakelite molded. The process is simple and quick, and enables a standardized routine and uniformity in grinding and polishing operations. This new method provides: (1) Absolute adherence of Bakelite molded to the specimens, (2) freedom from relief polish, margins, or crevices, (3) uniform shape of mounting and convenience of handling, (4) reagent resistance, (5) time saving and economy.

A new hydraulic press has been designed especially for the metallurgical and geological laboratory. This press has been developed by the Wilkens-Anderson Co., Chicago. The use of Bakelite molded for mountings is advantageous because the mountings will not heat up. They are convenient to handle and grind better than the soft alloys used previously. Bakelite molded holds the specimens much more firmly. It will not clog grinding wheels. The Bakelite molded materials can easily be brushed off from abrasive wheels or emery paper.

Any metal specimen can be mounted easily in Bakelite molded. The operation is so clean and so rapid that it should soon become a standard routine in metallurgical and geological laboratories. Still another advantage of using Bakelite molding material is that various colors may be selected to obtain the best contrast with specimens.

A Low-Price Accurate Balance

There has always been a need for a low priced balance (scale) of great accuracy. The result of 7 yr's. work and modern manufacturing methods has made possible the Bennett Balance which has aroused such wide-spread interest.

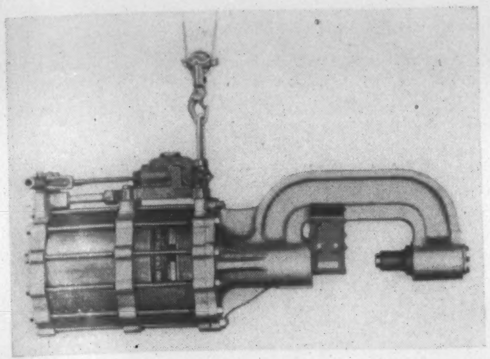
The Bennett Balance, offered by the Chemical Publishing Co., 175 Fifth Ave., New York, weighs up to 100 grams and has a sensitivity of 1/100th of a gram. It is a rugged, compact device, less than 1 lb. in weight and about 12 in. long. Because of its small size and weight it can be carried in a pocket from place to place where ordinary balances would be too clumsy and heavy. Its gleaming, black Bakelite, shining light metal alloy construction and modernistic design make it a thing of beauty as well. There are no loose weights to be lost. It has an alloy steel knife edge and a highly polished agate bearing which make for great sensitivity and durability. A special beam arrest prevents excessive wear of the knife edge and centers the latter automatically for each weighing.

The low price ($5.00) makes it possible for many to have a number of such balances conveniently located in various parts of laboratories and factories.

A Portable Pneumatic Press

The portable pneumatic press, as illustrated, is a recent development of the Hanna Engineering Works, Chicago.

Although designed to fill the need for a portable tool for pressing spring shackle bushings and pins in automobile chassis frames, it is finding rather general application for pressing, punching, riveting, upsetting and marking operations. The press here illustrated is tooled for pressing shackle bushings in chassis frames. Equipped with a hopper feed for the bushings, the operator need only locate the index pin in the chassis frame, operate the valve trigger and the bushing is driven in with a pre-determined pressure. There is no need to start the pin or bushing in the hole prior to the application of the press. Two cylinders separated by a diaphragm not only contribute to make this a very compact unit but effect a decided saving in air comsumption.



The extensive use of aluminum alloy castings is reflected in the weight which is 135 lb. Suspended from a balancer it is truly a portable tool. It is available in capacities of 3, 4 and 5 tons and while standard yokes of varying reach and gap are offered, yokes are usually designed to "fit the job."

"Kanthal"—A New Electrical Resistance Alloy

A new electrical resistance alloy—"Kanthal"—with operating temperature of better than 2450 deg. F. is now being marketed by the C. O. Jelliff Mfg. Corp., Southport, Conn. It not only operates at higher temperatures than any other previously known base metal or alloy without protective gases, but also possesses remarkable oxidation resisting qualities, it is claimed. It has a much higher specific resistance (35 to 40%) and lower specific gravity (10 to 15%) than Ni-Cr alloys. It is particularly free from attack in the presence of sulphur.

Three grades of "Kanthal" are available: A-1 maximum 2462 deg. F. for electric furnaces; A-1 maximum 2372 deg. F. for domestic appliances; D maximum 1150 deg. F. for most purposes where Ni-Cr is now used, to which it has the advantage of lower cost and longer life at equivalent temperatures.

The Jelliff Corporation has gathered together much interesting data concerning "Kanthal" alloys, their resistance to sulphurous vapors, electrical resistance, durability, etc., which are available.

Smith Alloy No. 10

The Hevi Duty Electric Co., Milwaukee, announces that it has acquired by purchase from the A. O. Smith Corp. all rights and patents relating to Smith Alloy No. 10 which is a new heat-resisting alloy. This is an alloy of Fe—Cr—Al and is claimed to make available to industry electric heat up to 2400 deg. F. with metallic resistors. Arrangements are being completed for the commercial production of this alloy as resistors of various sizes and as castings. The alloy was invented by S. L. Hoyt and R. S. Archer, well-known metallurgists.

An Insulating Refractory Concrete

A new hydraulic insulating refractory concrete known as "Insulcrete," that takes the place of firebrick and insulation combined in poured refractory furnace linings, boiler baffles, etc., has been developed by the Quigley Co., Inc., 56 West 45th St., New York.

This new development is said to possess the unique properties of interlocking crystalline minerals forming a cellular heat-insulating, heat-resisting, high-load carrying, and low permeation refractory. Also, due to its low heat storage, and low thermal conductivity when poured to form a lining or baffle; the boiler or furnace becomes *more sensitive to automatic control, saving fuel and increasing* output. "Insulcrete" makes monolithic (jointless), air-and-gas-tight furnace linings. It is the ideal lining for all domestic oil and gas heaters, particularly with oil firing, as "Insulcrete" makes a sound proof lining.

It is said that "Insulcrete" does not shrink after being poured in furnace wall or boiler baffle, *i.e.,* 1 cu. ft. in a dry state weighs 60 lb., and after mixing with water, poured and allowed to acquire hydraulic set for 24 hrs., 1 cu. ft. dried weighs 60 lb.

Under continuous operation at 2,500 deg. F. furnace temperature the expansion or contraction is said to be negligible. It is recommended to provide joints for taking up movement of structure on which, or in which, it is placed as it is common practice with any refractory which has little elasticity. At a mean temperature of 1100 deg. F. it has a thermal conductivity of 3.13 compared with first quality firebrick which at the same temperature is 8.16. It is a 62¼ per cent better insulator and has less than half the heat storage of firebrick, which makes it both a *fuel* and *time saver.*

"Insulcrete's" special features and low cost of installation make it adaptable for all types of heat-treating furnaces, flues, pot furnaces, boiler walls and baffles, domestic fireplaces and furnaces, ovens, open-hearth regenerators, stack linings, doors, soaking pit covers, malleable iron annealing furnaces, producer and blast furnace gas mains, oil refining furnaces, galvanizing tin furnaces, etc. The relining of existing furnaces pays for the cost of improvements many times over the first year used based on the savings in cost of fuel. The furnace output is increased due to greater temperature difference between metal and flame, because it soaks the metal at a higher rate of heating instead of the masonry.

Small gas forging, wire drawing, heat-treating furnaces, etc., may be cast in a single piece. Gas Fired Insulcrete lined furnaces attain a working temperature in one-third the time and operate at approximately 100 deg. F. higher temperature than an ordinary fireclay brick furnace.

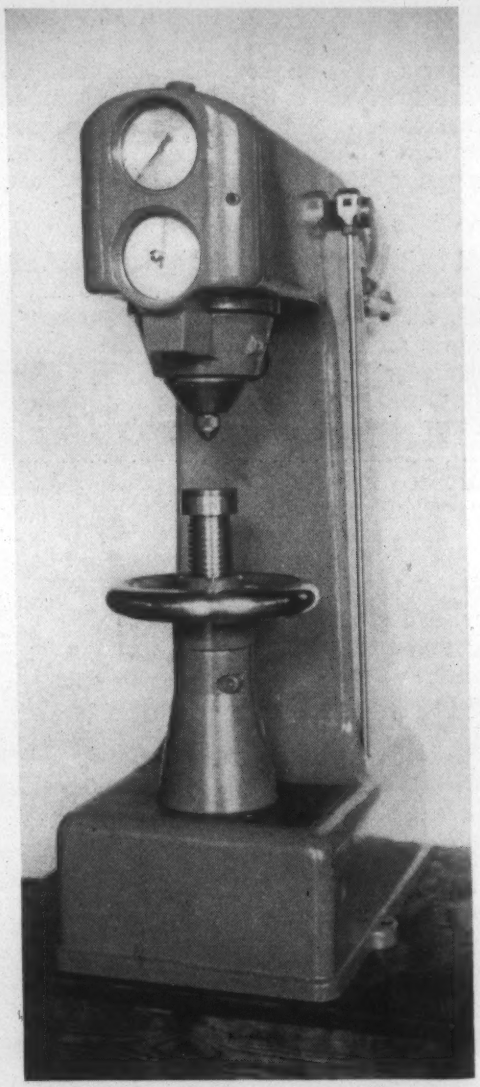
Furnace for Heat Treating "Mo-Max"

Phenomenal performance of the new molybdenum high-speed steel tools "Mo-Max" heat treated in the Bellis "Lavite" furnace, is reported by the tap, die and twist drill manufacturers, according to the Bellis Heat Treating Co., Branford, Conn. The regular Bellis furnace is used. The right hand section of the furnace is used for preheating at 1500 deg. F.; the middle section at 2175 deg. F. for the high heat; and the left hand section at 1100 to 1200 deg. F. for interrupted quenching. A separate tempering operation at 1040 deg. F. for 30 min. is recommended. The time in the high heat has to be varied between ½ min. to several minutes, depending on the size of the pieces. This time is recommended by the Bellis company on the basis of experience with pieces of similar size and from grain inspection tests.

New Direct Reading Brinell Machine

A new and interesting development in the hardness testing field is a power driven, direct reading Brinell machine recently introduced by the Detroit Testing Machine Co., Detroit. Testing is done on the rough surface without spotting or stops for reading and the money and labor saving possibilities of such a device will be readily apparent to those doing extensive "brinelling."

It is claimed that by the use of this equipment Brinell testing is stepped up in line with other production operations. Tolerance hands on the face of an indicating dial are set to the desired limits by using the microscope after which the operator merely notes that the pointer stops within them. Since the actual test made is the standard Brinell, it may be checked with the microscope at any time, eliminating all possibility of error. This also permits the use of the machine in the conventional manner on odd specimens. A foot pedal is provided leaving the operator's hands free. This greatly facilitates the handling of parts.



The direct reading device works equally well on flat, rounded or odd shapes and is mounted in such a manner as to be entirely free from deflection in the machine frame. This permits a deep throat depth and gives a correspondingly greater work capacity. Where the machine is to be used on small parts a suitable sleeve or distance-piece is provided which supports the screw well up under the nut or handwheel. The screw may be clamped rigidly thus being free from shake and excessive wear. The frame is cast in one piece and is of box-section construction. In addition the machine is ruggedly constructed to withstand production use. Two sizes are available: One having a work-gap 6 by 12 in. and the other 9 by 18 ins. It is available also without the direct reading feature for those requiring a plain motor driven Brinell.

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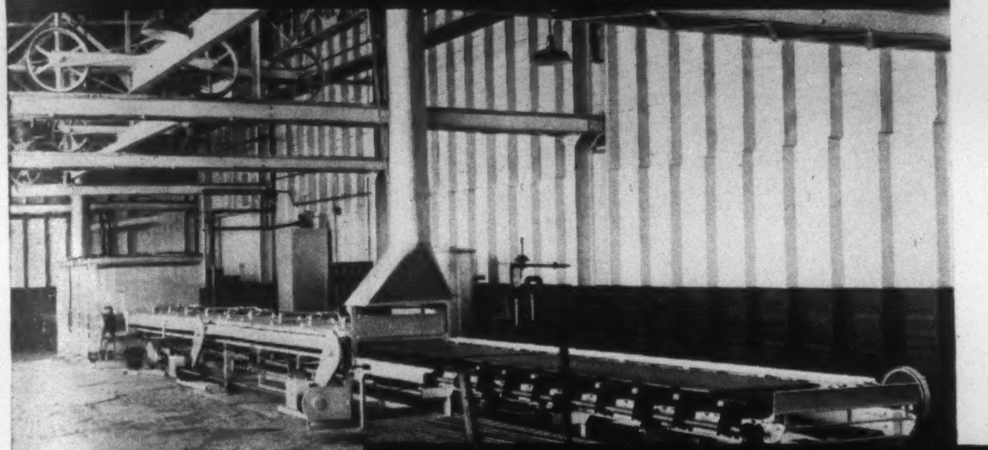
Continuous CONTROLLED ATMOSPHERE FURNACES

Designed to Fit Your Specific Requirements

The several installations shown represent a few of the various types of controlled atmosphere furnaces we have built for scale-free heat treating, brazing, and bright annealing miscellaneous ferrous and non-ferrous products in various shapes and forms.

Bright Annealing



(Left) A recent installation for bright annealing cold drawn seamless steel tubing. Other outstanding installations made for bright annealing ferrous and non-ferrous stampings, wire, sheet, strip and tubing in coils and straight lengths.

Brazing and Soldering

(Right) Two pusher type furnaces brazing miscellaneous automotive and refrigerator parts. The assemblies are automatically conveyed through the furnace and discharged completely brazed—clean and bright. Other types and sizes for various other products.

(Below) One of our standard continuous chain belt conveyor type furnaces designed for use with our inexpensive Elfurno gas atmosphere for clean and bright hardening bolts, screws and other small and medium size products.

Scale-free Heat Treating

The application of controlled atmosphere equipment to the annealing, heat treating and brazing of metals has advanced rapidly since the development of our inexpensive Elfurno gas atmosphere. It should be given serious consideration in the planning of new furnace equipment or the modernization of present equipment.

Our engineers will be glad to discuss our developments in controlled atmosphere equipment or work with you on any of your furnace or heat treating problems.

THE ELECTRIC FURNACE CO.

SALEM, OHIO.

Fuel Fired Furnaces

Electric Furnaces

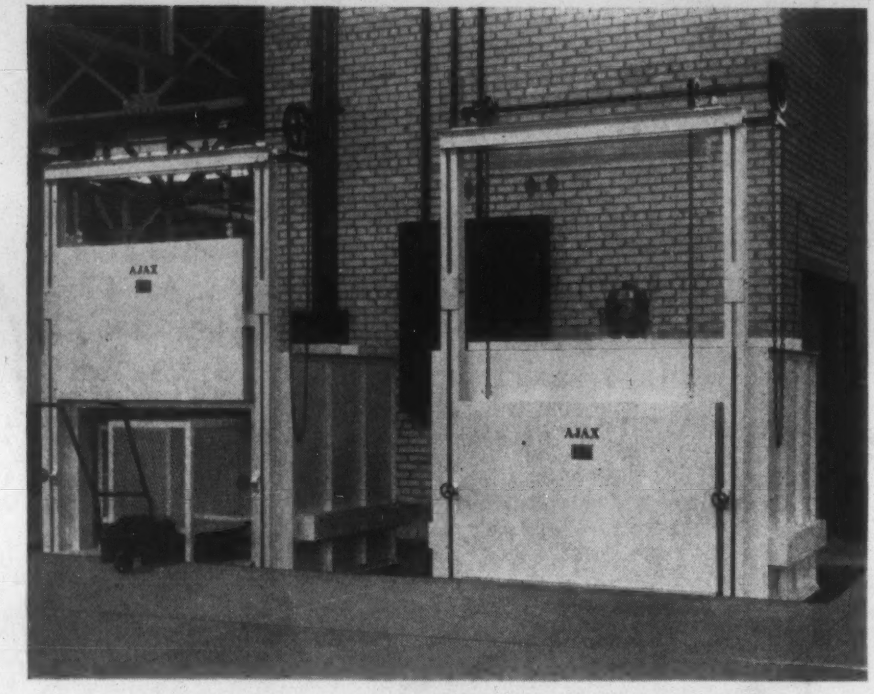
ELECTRIC FURNACES—CONTINUOUS OR BATCH TYPE

for

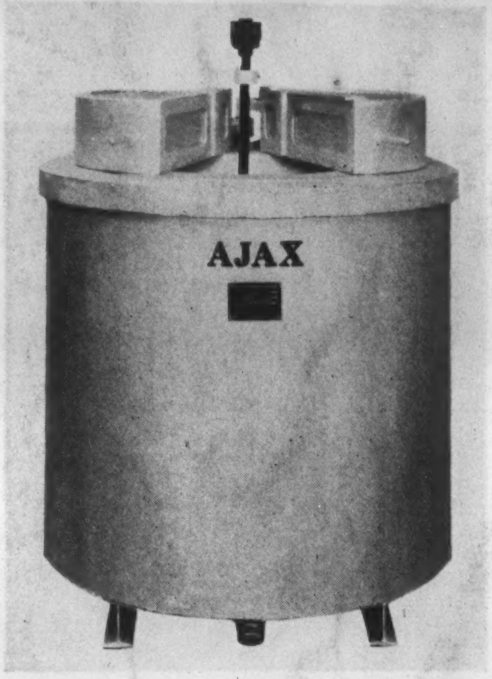
BRIGHT ANNEALING
NORMALIZING
HARDENING

TEMPERING
COPPER BRAZING
STRIP ANNEALING

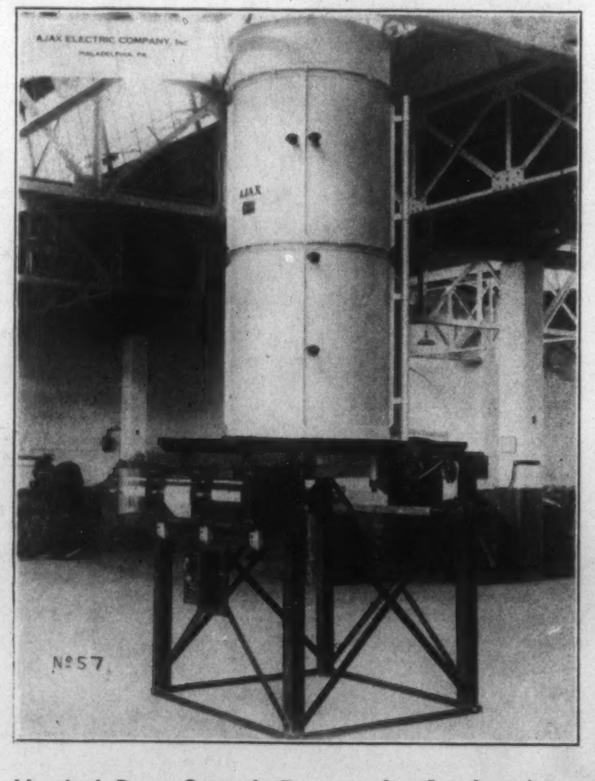
CARBURIZING
NITRIDING
ETC., ETC.



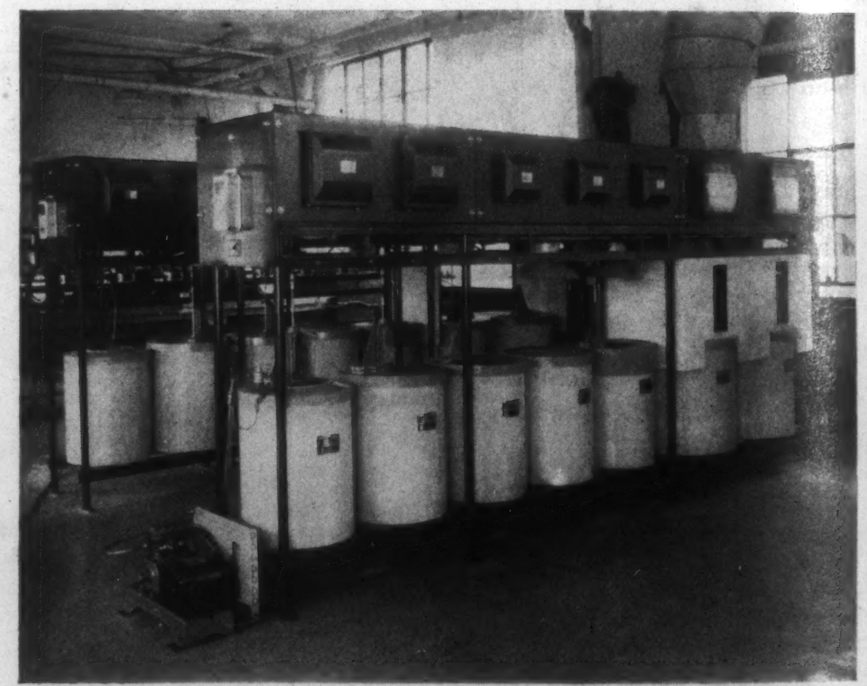
Tempering Ovens—with Air Agitation for Uniformly Heating Charges in Baskets—Up to 1200° F.



Pot Type Furnace Suitable for Lead, Salt, Cyanide, "Aerocase," "Perliton" and the "Chapmanizing" Process.



Vertical Drop Quench Furnace for Steel and Duralumin Tubing, and Long Sections.



Battery of Ajax Pot Furnaces including Salt Baths, Oil Baths and Water Baths Used by Prominent Instrument Manufacturer for Calibrating Thermocouples and Thermometer Bulbs.

AJAX ENGINEERS WILL GLADLY ANALYSE YOUR REQUIREMENTS AND RECOMMEND THE PROPER TYPE FURNACES TO SOLVE YOUR PROBLEMS

ELECTRIC HEAT APPLIED TO ALL INDUSTRIAL HEATING AND DRYING PROCESSES

AJAX ELECTRIC COMPANY, Inc.

DIVISION OF THE AJAX METAL COMPANY
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